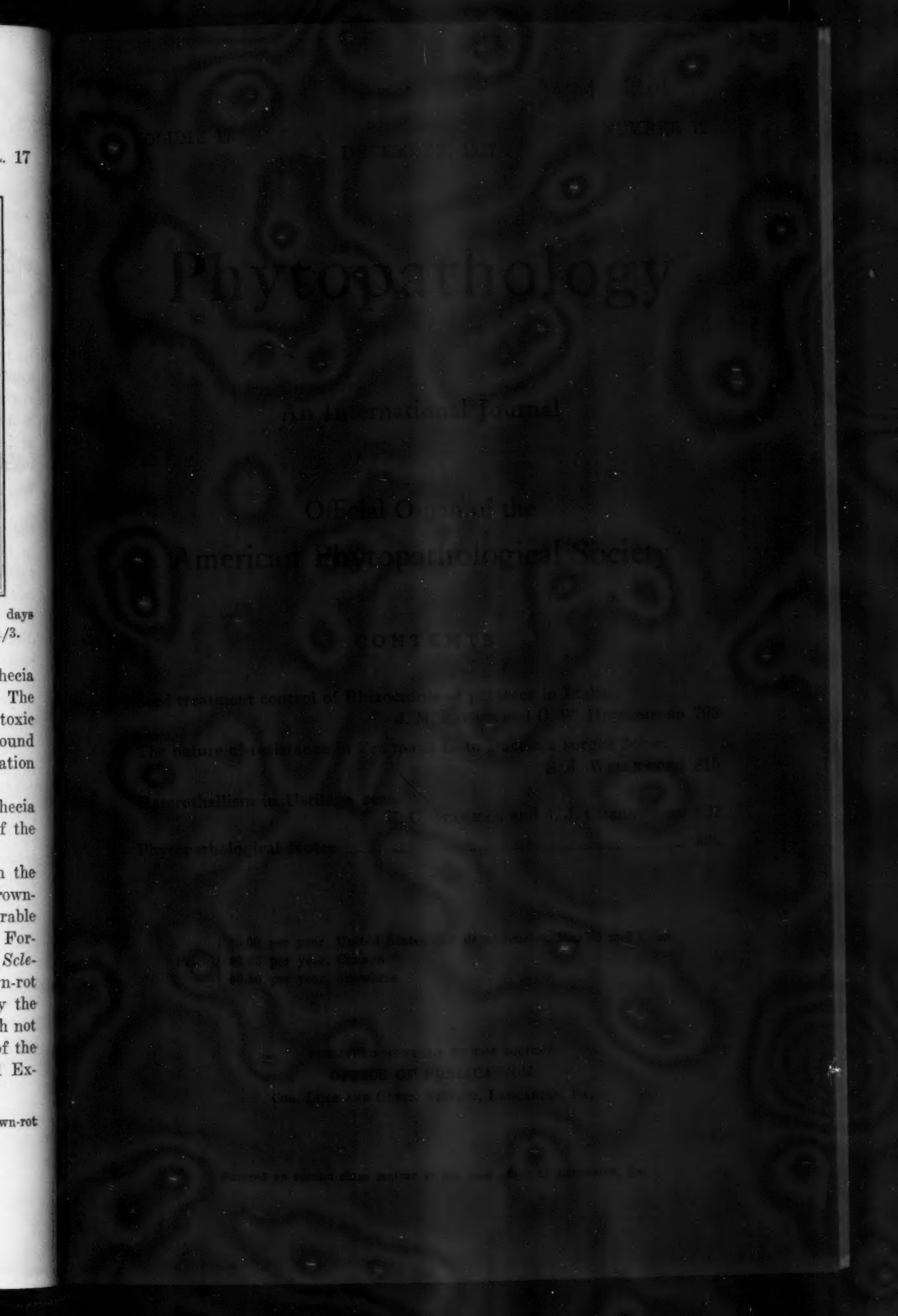

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SEED TREATMENT CONTROL OF RHIZOCTONIA OF POTATOES IN IDAHO[1]

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INTRODUCTION

Experiments conducted in 1924 and in previous years[2] with various potato seed treatments were continued in 1925 and 1926 at the Idaho Agricultural Experiment Station. These tests, although not identical in every respect for the three years, were nevertheless similar enough, in methods of application, procedure and tabulation, so that comparison of the various years' results can readily be made.

The reason these treatments were not identical was that, from year to year, certain methods of treatment or certain compounds were found unsatisfactory and discontinued, or new compounds appeared which were worthy of trial.

Considerable emphasis was placed upon presprinkling. By this is meant the thorough wetting of each tuber to be treated 48 hours previous to treatment, then piling and covering, in order to keep them moist during that time. The same procedure was followed in 1925 as in previous years. Each treatment was used with and without presprinkling. Having concluded that presprinkling produced sufficient increase in effectiveness of control, this procedure was used with all treatments in 1926.

EXPERIMENTAL DATA FOR 1925

A series of 31 treatments was used for the main test, including two untreated checks. Each treatment was replicated three times, each replication consisting of 100 seed pieces, averaging 2 to 3 ounces in weight, planted in a 120-foot row. Each row was harvested separately, and averages for the three replications were computed. Percentages were based on both weights

[1] Approved for publication by the Director of the Idaho Agricultural Experiment Station as Research Paper No. 45.

[2] Raeder, J. M., C. W. Hungerford, and Naomi Chapman. Seed treatment control of rhizoctonia in Idaho. Idaho Agr. Exp. Sta. Res. Bul. 4. 1925.

and numbers. Average percentages were based on the average production of the three replications for each treatment.

In tabulating results, the tubers from each row were divided into four groups, namely, clean marketable tubers, diseased marketable tubers, clean culls and diseased culls. The division between marketable tubers and culls was based upon size. All tubers over one and three-fourth inches in diameter were considered marketable. Tubers showing even a single sclerotium were considered diseased. The Netted Gem variety of potatoes was used in these trials.

In tabulating results, both weight and number of tubers were listed for each classification. Percentages were based on both tabulations. It is interesting to note that when both methods are used the results are quite similar. This holds true for either the total percentage of control or total percentage infected. Such is not the case for the smaller divisions, as for example, percentage of clean marketable tubers, clean culls, etc.

Table 1 gives the list of treatments used in 1925. It also gives the yields for each replication of each treatment, the percentage of control secured for each replication of each treatment, and the total percentage of control.

Best control was obtained with Semesan when applied at the rate of 2 ounces per bushel to presprinkled seed, although the control obtained with the same dust when applied at the rate of 3 ounces per bushel on presprinkled seed was nearly as good. The former gave 98.5 per cent control on the basis of weights and 98.3 per cent on the basis of numbers. The latter

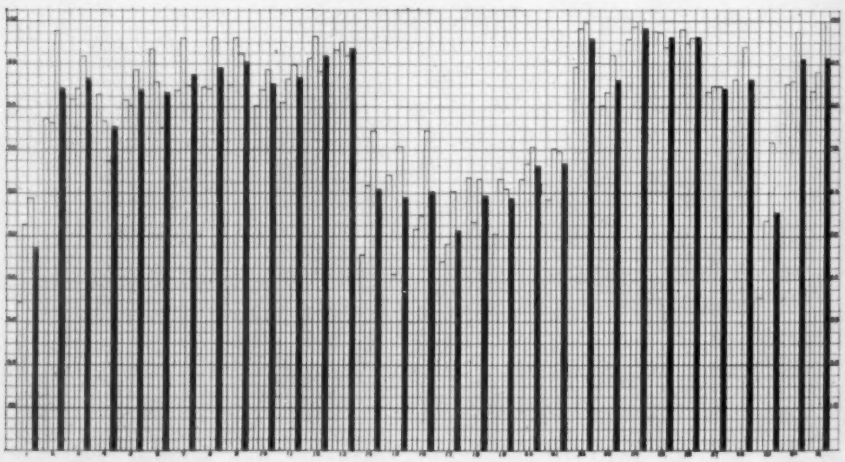


FIG. 1. Percentages of clean tubers by weight secured by various seed treatments (table 1) for the control of rhizoctonia of potatoes in 1925 at Moscow, Idaho. Three replications and average for each treatment.

produced 96.1 per cent control on the basis of weights and 96.2 per cent on the basis of numbers.

Contrary to expectations, Semesan, in 1925, surpassed Dupont Dust No. 15 in effectiveness. This was not the case in 1924. Hot formalin when used at a temperature of 50° C. for four minutes was quite uniform in its control both years, producing 82.7 per cent control by weight and 80.5 per cent control by number in 1924, and 81.3 per cent control by weight and 84.0 per cent control by number in 1925.

Figure 1 gives in graphic form the results obtained in 1925 for each replication and the average of each treatment when the percentages were based on weights. Figure 2 gives the results when based on numbers, and figure 3 shows a comparison of the average controls obtained by both the above methods.

Stand counts were made in 1925. Table 2 gives in detail the results of these counts. Upon examining this table, it will be noticed that the furfural treatments were quite injurious to germination. This is particularly true with presprinkled seed. This factor in itself would necessarily eliminate this chemical from the list of desirable potato seed treating compounds. All other counts showed over 90 per cent stand except that on plants treated with Semesan when applied to presprinkled seed at the rate of 3 ounces per bushel.

Because the results obtained in 1924 with Dupont Dust No. 15 were so satisfactory, a series of tests with this disinfectant was conducted in 1925 in comparison with the standard mercuric chloride and hot formalin method.

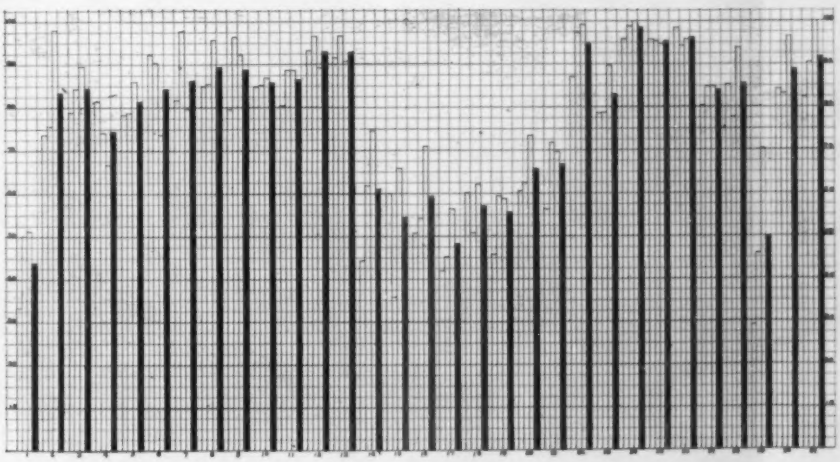


FIG. 2. Percentages of clean tubers by number secured by various seed treatments (table 1) for the control of rhizoctonia of potatoes in 1925 at Moscow, Idaho. Three replications and average for each treatment.

TABLE 1.—*The effectiveness of various seed treatments in controlling rhizoctonia of potatoes in 1925 at Moscow, Idaho*

Treatment	Plot	Total control in per cent by wt.	Total control in per cent by no.	Marketable tubers								Culls							
				Clean				Diseased				Clean				Diseased			
				Wt.[a]	%	No.	%	Wt.[a]	%	No.	%	Wt.[a]	%	No.	%	Wt.[a]	%	No.	%
1. Check (no treatment)	1	33.3	34.6	11.5	23.2	59	16.2	23.5	47.5	119	32.6	5.0	10.1	67	18.4	9.5	19.1	120	32.9
	2	50.0	52.7	8.0	22.9	33	11.9	10.0	28.6	47	16.9	9.5	27.1	113	40.8	7.5	21.4	84	30.3
	3	51.2	58.9	12.0	29.3	57	21.5	15.0	36.6	61	23.0	9.0	21.9	99	37.4	5.0	12.2	48	18.1
	Ave.	43.8	47.2	10.5	25.1	49.7	16.4	16.2	38.8	75.7	25.0	7.8	18.7	93.0	30.8	7.3	17.5	84	27.8
2. Cold formalin (1–240), 1½ hrs. soak	1	73.6	77.3	11.0	25.3	48	13.2	5.5	12.6	23	6.3	21.0	48.3	234	64.1	6.0	13.8	60	16.4
	2	75.7	76.4	21.5	58.1	96	40.3	7.0	18.9	31	13.0	6.5	17.6	86	36.1	2.0	5.4	25	10.5
	3	98.0	97.8	39.0	78.0	187	56.8	1.0	2.0	7	2.1	10.0	20.0	135	41.0	0.0	0.0	0	0.0
	Ave.	83.4	84.3	23.8	54.7	110.3	35.5	4.5	10.3	20.3	6.5	12.5	28.7	151.7	48.8	2.7	6.2	28.3	9.1
3. do presprinkled	1	78.9	81.9	19.0	42.2	77	29.1	7.5	16.7	30	11.3	16.5	36.7	140	52.8	2.0	4.4	18	6.8
	2	84.3	84.3	21.5	51.8	83	34.3	4.5	10.8	19	7.9	13.5	32.5	121	50.0	2.0	4.8	19	7.9
	3	89.5	91.7	21.0	44.2	93	26.3	3.5	7.4	15	4.2	21.5	45.3	231	65.4	1.5	3.2	14	3.9
	Ave.	84.4	86.6	20.5	45.9	84.3	29.4	5.2	11.6	21.3	7.4	17.2	38.5	164.0	57.2	1.8	4.0	17.0	5.9
4. Formalin (1–120), 50° C., 4 min.	1	81.4	83.0	26.5	54.6	110	35.4	7.0	14.4	28	9.0	13.0	26.8	148	47.6	2.0	4.1	25	8.0
	2	74.1	76.7	17.5	43.2	73	28.9	7.5	18.5	26	10.4	12.5	30.9	121	47.8	3.0	7.4	33	13.0
	3	66.7	67.4	16.5	35.5	71	21.3	9.0	19.4	37	11.1	14.5	31.2	154	46.1	6.5	13.9	72	21.6
	Ave.	74.3	75.5	20.2	44.8	84.7	28.3	7.8	17.3	30.3	10.1	13.3	29.5	141.0	47.2	3.8	8.4	43.3	14.5
5. do presprinkled	1	78.4	81.6	25.0	49.0	110	31.5	8.0	15.7	31	8.9	15.0	29.4	175	50.1	3.0	5.9	33	9.5
	2	78.8	80.2	20.5	57.7	103	38.6	5.5	15.5	26	9.7	7.5	21.1	111	41.6	2.0	5.6	27	10.1
	3	86.0	88.7	26.0	52.0	137	35.3	6.0	12.0	30	7.7	17.0	34.0	207	53.4	1.0	2.0	14	[illegible]
	Ave.	81.3	84.0	23.8	52.3	116.7	34.9	6.5	14.3	29.0	8.7	13.2	29.0	164.3	49.1	2.0	4.4	24.7	
6. Formalin (1–120), 55° C., 4 min.	1	92.3	93.4	22.5	57.7	79	34.5	2.5	6.4	10	4.4	13.5	34.6	135	58.9	0.5	1.3	5	2.2
	2	90.4	85.8	33.5	71.3	137	47.4	3.0	6.4	13	4.5	9.0	19.1	111	38.4	1.5	3.2	28	9.7
	3	73.6	75.2	32.0	56.1	146	40.7	11.5	20.2	52	14.5	10.0	17.5	124	34.5	3.5	6.1	37	10.3
	Ave.	84.3	83.4	29.3	61.6	120.7	41.3	5.7	11.9	25.0	8.6	10.8	22.7	123.3	42.1	1.8	3.8	23.3	7.9
7. do presprinkled	1	81.6	83.9	19.5	51.3	84	33.9	5.5	14.5	23	9.3	11.5	30.3	124	50.0	1.5	3.9	17	6.9
	2	97.7	95.9	32.0	74.4	138	51.7	0.5	1.2	3	1.1	10.0	23.3	118	44.2	0.5	1.2	8	2.9
	3	79.6	84.9	16.5	33.7	68	18.3	6.5	13.3	23	6.2	22.5	45.9	247	66.6	3.5	7.1	33	8.9
	Ave.	86.2	87.9	22.7	52.3	96.7	32.7	4.2	9.7	16.3	5.5	14.7	33.9	163.0	55.2	1.8	4.1	19.3	6.5
8. Furfural (1–60), 10 min., 50° C.	1	84.9	84.7	24.0	55.8	107	37.9	4.5	10.5	20	7.1	12.5	29.1	132	46.8	2.0	4.7	23	8.2
	2	85.5	84.3	27.5	61.1	129	40.4	3.5	7.8	16	5.0	11.0	24.4	140	43.9	3.0	6.7	34	10.7
	3	95.6	96.2	31.0	55.4	134	36.6	2.0	3.6	9	2.5	22.5	40.2	218	59.6	0.5	0.9	5	1.4
	Ave.	89.3	89.0	27.5	57.4	123.3	38.3	3.3	6.9	15.0	4.7	15.3	31.9	163.3	50.7	1.8	3.8	20.7	6.4

Treatment	Plot	Total control in per cent by wt.	Total control in per cent by no.	Marketable tubers: Clean: Wt.[a]	Marketable tubers: Clean: %	Marketable tubers: Clean: No.	Marketable tubers: Clean: %	Marketable tubers: Diseased: Wt.[a]	Marketable tubers: Diseased: %	Marketable tubers: Diseased: No.	Marketable tubers: Diseased: %	Culls: Clean: Wt.[a]	Culls: Clean: %	Culls: Clean: No.	Culls: Clean: %	Culls: Diseased: Wt.[a]	Culls: Diseased: %	Culls: Diseased: No.	Culls: Diseased: %
8. Furfural (1–60), 10 min., 50° C.	1	84.3	84.3	27.5	61.1	129	40.4	3.5	7.8	16	5.0	11.0	24.4	140	43.9	3.0	6.7	34	10.7
	2	85.5	84.3	27.5	61.1	129	40.4	3.5	7.8	16	5.0	11.0	24.4	140	43.9	3.0	6.7	34	10.7
	3	95.6	96.2	31.0	55.4	134	36.6	2.0	3.6	9	2.5	22.5	40.2	218	59.6	0.5	0.9	5	1.4
	Ave.	89.3	89.0	27.5	57.4	123.3	38.3	3.3	6.9	15.0	4.7	15.3	31.9	163.3	50.7	1.8	3.8	20.7	6.4

TABLE 1.—(*Continued*)

Treatment	Plot	Total control in per cent by wt.	Total control in per cent by no.	Marketable tubers: Clean: Wt.[a]	Marketable tubers: Clean: %	Marketable tubers: Clean: No.	Marketable tubers: Clean: %	Marketable tubers: Diseased: Wt.[a]	Marketable tubers: Diseased: %	Marketable tubers: Diseased: No.	Marketable tubers: Diseased: %	Culls: Clean: Wt.[a]	Culls: Clean: %	Culls: Clean: No.	Culls: Clean: %	Culls: Diseased: Wt.[a]	Culls: Diseased: %	Culls: Diseased: No.	Culls: Diseased: %
9. Furfural (1–60), 10 min., 50° C., presprinkled	1	79.6	85.0	26.0	59.1	124	45.4	8.0	18.2	31	11.4	9.0	20.5	108	39.6	1.0	2.3	10	3.7
	2	96.3	96.0	22.0	81.5	78	61.9	0.5	1.9	3	2.4	4.0	14.8	43	34.1	0.5	1.9	2	1.6
	3	92.3	92.4	26.0	50.0	102	30.5	3.0	5.8	9	2.7	22.0	42.3	207	61.9	1.0	1.9	16	4.8
	Ave.	88.7	90.4	24.7	60.2	101.3	41.5	3.8	9.3	14.3	5.9	11.7	28.5	119.3	48.9	0.8	1.9	9.3	3.8
10. Furfural (1–120), 10 min., 55° C.	1	84.7	80.2	23.5	65.3	86	42.6	4.0	11.1	19	9.4	7.0	19.4	76	37.6	1.5	4.2	21	10.4
	2	85.1	84.0	27.5	68.8	112	47.1	5.0	12.5	23	9.7	6.5	16.3	88	36.9	1.0	2.5	15	6.3
	3	87.0	88.8	31.5	58.3	147	41.2	6.0	11.1	25	7.0	15.5	28.7	170	47.6	1.0	1.9	15	4.2
	Ave.	85.8	85.2	27.5	63.4	115.0	43.3	5.0	11.5	22.3	8.4	9.7	22.4	111.3	41.9	1.2	2.8	17.0	[illegible]
11. do presprinkled	1	80.4	81.0	14.5	63.0	66	46.5	3.5	15.2	15	10.6	4.0	17.4	49	34.5	1.0	4.3	12	8.5
	2	88.6	86.5	17.5	66.0	69	44.2	1.5	5.7	5	3.2	6.0	22.6	66	42.3	1.5	5.7	16	10.3
	3	88.6	89.9	25.0	63.3	118	44.0	3.5	8.9	16	5.9	10.0	25.3	123	45.9	1.0	2.5	11	4.1
	Ave.	86.5	86.7	19.0	63.9	84.3	44.7	2.8	9.4	12.0	6.4	6.7	22.6	79.3	42.0	1.2	4.0	13.0	6.9
12. Mercuric chloride (1–1,000), 1½ hrs. soak	1	93.2	91.3	28.5	78.1	124	60.2	2.0	5.5	12	5.8	5.5	15.1	64	31.1	0.5	1.4	6	2.9
	2	96.5	96.3	30.5	71.8	135	50.0	1.0	2.4	4	1.5	10.5	24.7	125	46.3	0.5	1.2	6	2.2
	3	89.2	88.2	28.0	60.9	110	38.5	3.0	6.5	12	4.2	13.0	28.3	142	49.7	2.0	4.3	22	7.7
	Ave.	92.8	91.8	29.0	69.5	123.0	48.4	2.0	4.8	9.3	3.7	9.7	23.3	110.3	43.4	1.0	2.4	11.3	4.5
13. do presprinkled	1	91.5	93.3	25.0	53.2	96	32.0	3.0	6.4	10	3.3	18.0	38.3	184	61.3	1.0	2.1	10	3.3
	2	96.6	95.0	27.5	61.8	118	39.9	0.5	1.1	4	1.4	15.5	34.8	163	55.1	1.0	2.2	11	3.7
	3	90.8	91.9	30.5	70.1	134	51.3	3.0	6.9	14	5.4	9.0	20.7	106	40.6	1.0	2.3	7	2.7
	Ave.	92.9	93.5	27.7	61.4	116.0	40.6	2.2	4.9	9.3	3.3	14.2	31.5	151.0	52.9	1.0	2.2	9.3	3.3
14. Check (no treatment)	1	44.4	45.6	14.0	31.1	63	19.4	18.0	40.0	86	26.5	6.0	13.3	85	26.2	7.0	15.5	91	28.0
	2	62.4	61.8	18.0	38.7	80	21.6	10.0	21.5	51	13.7	11.0	23.7	149	40.2	7.5	16.1	91	24.5
	3	74.8	74.5	14.5	29.3	53	15.2	6.0	12.1	25	7.2	22.5	45.5	207	59.3	6.5	13.1	64	18.3
	Ave.	61.0	60.9	15.5	32.9	65.3	18.7	11.3	24.0	54.0	15.5	13.2	28.1	147.0	42.2	7.0	14.9	82.0	23.5
15. Dupont dust No. 15, 1 oz. per bu.	1	60.0	64.2	16.0	40.0	75	26.6	12.5	31.3	56	19.9	8.0	20.0	106	37.6	3.5	8.8	45	15.9
	2	35.9	41.1	8.5	18.5	40	12.2	20.5	44.6	88	26.8	8.0	17.4	95	28.9	9.0	19.6	105	32.0
	3	66.0	70.8	24.5	44.9	114	30.6	15.0	27.5	63	16.9	11.5	21.1	150	40.2	3.5	6.4	46	12.3
	Ave.	54.5	59.0	16.3	34.8	76.3	23.3	16.0	34.2	69.0	21.1	9.2	19.7	117.0	35.7	5.3	11.3	65.3	19.9
16. do presprinkled	1	50.7	51.6	12.0	32.9	52	20.8	11.5	31.5	51	20.4	6.5	17.8	77	30.8	6.5	17.8	70	28.0
	2	54.5	54.8	19.5	38.6	101	25.9	16.0	31.7	82	21.0	8.0	15.8	113	28.9	7.0	13.9	94	24.1
	3	71.0	74.5	15.0	30.0	54	17.6	8.0	16.0	30	9.8	20.5	41.0	174	56.9	6.5	13.0	48	15.7
	Ave.	59.5	60.3	15.5	33.9	69.0	21.8	11.8	25.8	54.3	17.2	11.7	25.6	121.3	38.5	6.7	14.7	70.7	22.4

TABLE 1.—(*Continued*)

Treatment	Plot	Total control in per cent by wt.	Total control in per cent by no.	Marketable tubers								Culls							
				Clean				Diseased				Clean				Diseased			
				Wt.[a]	%	No.	%	Wt.[a]	%	No.	%	Wt.[a]	%	No.	%	Wt.[a]	%	No.	%
17. Dupont dust No. 15, 2 oz. per bu.	1	42.0	44.1	13.0	29.5	61	18.4	19.5	44.3	98	29.6	5.5	12.5	85	25.7	6.0	13.6	87	26.3
	2	45.1	48.2	11.5	28.0	54	17.8	15.0	36.6	76	25.1	7.0	17.1	92	30.4	7.5	18.3	81	26.7
	3	56.4	60.3	18.0	35.6	72	21.4	14.0	27.7	50	14.9	10.5	20.8	131	38.9	8.0	15.8	83	24.7
	Ave.	48.2	51.1	14.2	31.3	62.3	19.3	16.2	35.8	74.7	23.1	7.7	16.9	102.7	31.8	7.2	15.9	83.7	25.9
18. do presprinkled	1	60.2	63.5	12.5	34.2	60	20.7	8.5	23.3	39	13.4	9.5	26.0	124	42.8	6.0	16.4	67	23.1
	2	50.8	53.1	15.5	26.7	64	15.6	19.5	33.6	87	21.2	14.0	24.1	154	37.5	9.0	15.5	106	25.8
	3	62.1	63.3	12.5	26.3	52	13.8	8.0	16.8	36	9.6	17.0	35.8	186	49.5	10.0	21.1	102	27.1
	Ave.	57.0	59.4	13.5	28.5	58.7	16.3	12.0	25.4	54.0	15.0	13.5	28.5	154.7	43.1	8.3	17.5	91.7	25.5
19. Dupont dust No. 15, 3 oz. per bu.	1	45.8	50.5	11.0	26.5	50	17.1	16.0	38.6	68	23.2	8.0	19.3	98	33.4	6.5	15.7	77	26.3
	2	59.5	63.3	21.5	40.6	106	29.7	15.0	28.3	67	18.8	10.0	18.9	120	33.6	6.5	12.3	64	17.9
	3	58.6	61.0	28.0	48.3	141	38.9	19.5	33.6	86	23.8	6.0	10.3	80	22.1	4.5	7.8	55	15.2
	Ave.	55.5	58.8	20.2	39.8	99.0	29.4	16.8	33.1	73.7	21.8	8.0	15.7	99.3	29.4	5.8	11.4	65.3	19.4
20. do presprinkled	1	60.5	63.2	24.0	44.0	122	31.1	16.5	30.3	82	20.9	9.0	16.5	126	32.1	5.0	9.2	62	15.8
	2	62.5	66.8	17.5	39.8	87	27.0	12.5	28.4	66	20.5	10.0	22.7	128	39.8	4.0	9.1	41	12.7
	3	73.4	70.6	20.5	43.6	85	26.3	6.5	13.8	30	9.3	14.0	29.8	143	44.3	6.0	12.8	65	20.1
	Ave.	65.7	66.3	20.7	42.9	98.0	28.2	11.5	23.9	61.3	17.6	11.0	22.8	132.3	38.1	5.0	10.4	56.0	16.1
21. Semesan dust, 1 oz. per bu.	1	56.4	58.5	16.5	42.3	84	30.3	13.0	33.3	65	23.5	5.5	14.1	78	28.2	4.0	10.3	50	18.1
	2	71.8	70.4	20.0	38.8	87	24.7	6.5	12.6	27	7.7	17.0	33.0	161	45.7	8.0	15.5	77	21.9
	3	69.6	69.6	27.0	52.9	113	34.9	12.0	23.5	54	16.7	8.5	16.7	112	34.7	3.5	6.9	44	13.6
	Ave.	66.7	66.7	21.2	44.9	94.7	29.8	10.5	22.2	48.7	15.3	10.3	21.8	117.0	36.9	5.2	11.0	57.0	17.9
22. do presprinkled	1	87.0	89.2	26.5	56.9	115	38.9	5.0	10.8	21	7.1	14.0	30.1	149	50.3	1.0	2.2	11	3.7
	2	97.3	98.2	37.5	66.9	168	48.1	1.0	1.8	3	0.9	17.0	30.4	175	50.1	0.5	0.9	3	0.9
	3	99.1	99.6	36.5	71.6	150	48.2	0.5	0.9	1	0.3	14.0	27.5	160	51.4	0.0	0.0	0	0.0
	Ave.	94.7	95.9	33.5	65.4	144.3	45.3	2.2	4.3	8.3	2.6	15.0	29.3	161.3	50.6	0.5	1.0	4.7	1.5
23. Semesan dust, 2 oz. per bu.	1	78.6	80.1	20.0	53.3	99	35.5	6.0	16.0	26	9.4	9.5	25.3	124	44.6	2.0	5.3	29	10.4
	2	78.7	83.4	27.0	57.4	143	44.5	9.0	19.1	40	12.5	10.0	21.3	125	38.9	1.0	2.1	13	4.0
	3	89.6	92.0	23.0	43.4	105	24.7	3.5	6.6	15	3.5	24.5	46.2	286	67.3	2.0	3.8	19	4.5
	Ave.	82.8	86.1	23.3	50.8	115.7	33.9	6.2	13.5	27.0	7.9	14.7	32.0	178.3	52.2	1.7	3.7	20.3	5.9
24. do presprinkled	1	95.9	95.7	27.5	74.3	110	52.6	1.0	2.7	6	2.9	8.0	21.6	90	43.1	0.5	1.4	3	1.4
	2	98.9	98.6	39.0	84.8	191	66.8	0.0	0.0	0	0.0	6.5	14.1	91	31.8	0.5	1.1	4	1.4
	3	100.0	100.0	34.0	79.1	142	55.0	0.0	0.0	0	0.0	9.0	20.9	116	44.9	0.0	0.0	0	0.0
	Ave.	98.5	98.3	33.5	79.9	147.6	58.8	0.3	0.7	2.0	0.8	7.8	18.6	99.0	39.5	0.3	0.7	2.3	0.9

24. do presprinkled	1	95.9	95.7	27.5	74.3	110	52.6	1.0	2.7	6	2.9	8.0	21.6	90	43.1	0.5	1.4	3	1.4
	2	98.9	98.6	39.0	84.8	191	66.8	0.0	0.0	0	0.0	6.5	14.1	91	31.8	0.5	1.1	4	1.4
	3	100.0	100.0	34.0	79.1	142	55.0	0.0	0.0	0	0.0	9.0	20.9	116	44.9	0.0	0.0	0	0.0
	Ave.	98.5	98.3	33.5	79.9	147.6	58.8	0.3	0.7	2.0	0.8	7.8	18.6	99.0	39.5	0.3	0.7	2.3	0.9

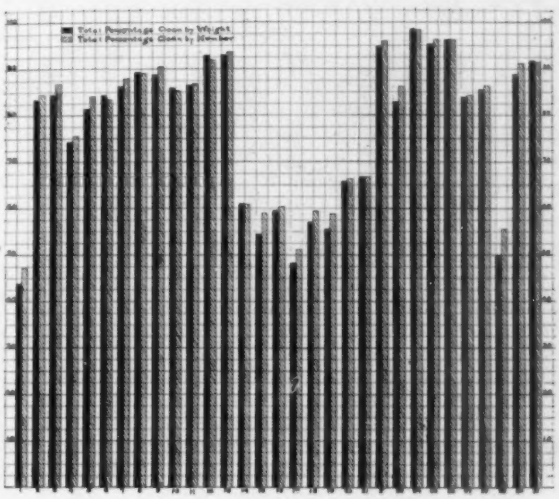
Treatment	Plot	Total control in per cent by wt.	Total control in per cent by no.	Marketable tubers								Culls							
				Clean				Diseased				Clean				Diseased			
				Wt.[a]	%	No.	%	Wt.[a]	%	No.	%	Wt.[a]	%	No.	%	Wt.[a]	%	No.	%
25. Semesan dust, 3 oz. per bu.	1	95.7	97.5	18.0	51.4	74	30.6	1.0	2.9	3	1.2	15.5	44.3	162	66.9	0.5	1.4	3	1.2
	2	95.3	97.2	24.0	55.8	140	43.8	1.5	3.5	5	1.6	17.0	39.5	171	53.4	0.5	1.2	4	1.3
	3	94.7	93.8	26.5	69.7	121	47.5	1.5	3.9	7	2.7	9.5	25.0	118	46.3	0.5	1.3	9	3.5
	Ave.	95.4	96.2	22.8	59.1	111.7	41.0	1.3	3.4	5.0	1.8	14.0	36.3	150.3	55.2	0.5	1.3	5.3	1.9
26. do presprinkled	1	98.5	98.0	22.5	65.2	86	42.8	0.5	1.4	2	0.9	11.5	33.3	111	55.2	Tr.	Tr.	2	0.9
	2	94.3	94.8	35.0	80.5	144	61.8	2.0	4.6	9	3.9	6.0	13.8	77	33.0	0.5	1.1	3	1.3
	3	95.7	96.0	35.0	75.3	147	53.5	1.5	3.2	5	1.8	9.5	20.4	117	42.5	0.5	1.1	6	2.2
	Ave.	96.1	96.2	30.8	74.4	125.7	53.2	1.3	3.1	5.3	2.2	9.0	21.7	101.7	43.0	0.3	0.7	3.7	1.6
27. Bayer dust, 2 oz. per bu., presprinkled	1	80.3	83.5	18.5	48.7	77	27.0	0.4	10.5	17	5.9	12.0	31.6	161	56.5	3.5	9.2	30	10.5
	2	84.8	84.8	21.0	42.4	77	26.0	4.5	9.1	18	6.1	21.0	42.4	174	58.8	3.0	6.1	27	9.1
	3	84.7	84.7	27.5	56.1	127	34.8	5.5	11.2	26	7.1	14.0	28.6	182	49.9	2.0	4.1	30	8.2
	Ave.	83.9	84.3	22.3	49.2	93.7	29.7	4.5	9.9	20.3	6.4	15.7	34.7	172.3	54.6	2.8	6.2	29.0	9.2
28. Bayer dust, 3 oz. per bu., presprinkled	1	85.3	86.3	21.0	51.2	104	32.4	4.5	10.9	22	6.9	14.0	34.1	173	53.9	1.5	3.7	22	6.9
	2	77.7	77.5	27.5	53.4	127	37.0	7.5	14.6	33	9.6	12.5	24.3	139	40.5	4.0	7.8	44	12.8
	3	93.8	94.3	25.5	52.6	127	33.1	1.5	3.1	6	1.6	20.0	41.2	235	61.2	1.5	3.1	16	4.2
	Ave.	85.5	86.4	24.7	52.6	119.3	34.2	4.5	9.6	20.3	5.8	15.5	32.9	182.3	52.2	2.3	4.9	27.3	7.8
29. Check (no treatment)	1	29.2	35.7	5.0	12.7	23	7.2	15.5	39.2	69	21.6	6.5	16.5	91	28.5	12.5	31.6	136	42.6
	2	46.0	53.6	9.0	15.9	40	9.1	17.5	30.9	80	18.2	17.0	30.1	196	44.5	13.0	23.0	124	28.2
	3	70.3	71.8	19.0	37.6	96	21.9	9.0	17.8	47	10.8	16.5	32.7	218	49.9	6.0	11.9	76	17.4
	Ave.	49.8	55.5	11.0	22.5	53.0	13.3	14.0	28.7	65.3	16.4	13.3	27.3	168.3	42.2	10.5	21.5	112.0	28.1
30. Clean seed, untreated	1	84.3	85.3	23.5	56.6	112	38.4	5.0	12.[illegible]	26	8.9	11.5	27.7	137	46.9	1.5	3.6	17	5.8
	2	83.1	86.0	21.0	44.2	95	27.1	5.0	10.5	18	5.1	18.5	38.9	206	58.9	3.0	6.3	31	8.9
	3	96.5	97.5	23.0	38.9	108	19.8	1.0	1.7	4	0.7	34.0	57.6	424	77.7	1.0	1.7	10	1.8
	Ave.	88.8	91.1	22.5	45.6	105.0	26.5	3.7	7.5	16.0	4.0	21.3	43.2	255.7	64.6	1.8	3.7	19.3	4.9
31. Clean seed, mercuric chloride (1–1,000), 1½ hrs. soak, presprinkled	1	82.2	83.6	20.0	54.8	94	36.9	4.5	12.3	20	7.8	10.0	27.4	119	46.7	2.0	5.5	22	8.6
	2	90.5	88.1	36.5	76.8	166	59.7	3.0	6.3	16	5.8	6.5	13.7	79	28.4	1.5	3.2	17	6.1
	3	100.0	100.0	20.0	42.1	91	26.9	0.0	0.0	0	0.0	27.5	57.9	247	73.1	0.0	0.0	0	0.0
	Ave.	91.6	91.4	25.5	58.1	117.0	40.3	2.5	5.7	12.0	4.1	14.7	33.5	148.3	51.1	1.2	2.7	13.0	4.5

[a] Weight in lbs.

TABLE 2.—*Percentage of control and stand counts of potatoes obtained with various seed treatments for the control of rhizoctonia at Moscow, Idaho, in 1925. Three hundred pieces planted for each treatment*

Treatment	Percentage clean by wt.	Percentage clean by no.	Stand				
			Replications			Total	Percentage
			1	2	3		
1. Check (no treatment)	43.8	47.2	100	100	97	297	99.0
2. Cold formalin (1–240), 1½ hrs. soak	83.4	84.3	99	94	98	291	97.0
3. do 1½ hrs. soak, presprinkled	84.4	86.6	98	98	96	292	97.3
4. Formalin (1–120), 50° C., 4 min.	74.3	75.5	93	91	96	290	96.7
5. do 50° C., 4 min., presprinkled	81.3	84.0	97	99	95	291	97.0
6. do 55° C., 4 min.	84.3	83.4	92	93	91	276	92.0
7. do 55° C., 4 min., presprinkled	86.2	87.9	94	90	97	281	93.7
8. Furfural (1–60), 50° C., 10 min.	89.3	89.0	93	100	98	291	97.0
9. do 50° C., 10 min., presprinkled	88.7	90.4	95	32	95	222	74.0
10. Furfural (1–120), 55° C., 10 min.	85.8	85.2	78	84	99	261	87.0
11. do 55° C., 10 min., presprinkled	86.5	86.7	70	51	82	203	67.7
12. Mercuric chloride (1–1,000), 1½ hrs. soak	92.8	91.8	98	100	100	298	99.3
13. do 1½ hrs. soak, presprinkled	92.9	93.5	99	100	100	299	99.6
14. Check (no treatment)	61.0	60.9	97	100	95	292	97.3
15. Dupont dust No. 15, 1 oz. per bu.	54.5	59.0	95	100	100	295	98.3
16. do 1 oz. per bu., presprinkled	59.5	60.3	100	100	99	299	99.6
17. do 2 oz. per bu.	48.2	51.1	100	98	100	298	99.3
18. do 2 oz. per bu., presprinkled	57.0	59.4	100	100	99	299	99.6
19. do 3 oz. per bu.	55.5	58.8	98	100	100	298	99.3
20. do 3 oz. per bu., presprinkled	65.7	66.3	100	100	98	298	99.3
21. Semesan dust, 1 oz. per bu.	66.7	66.7	100	100	95	295	98.3
22. do 1 oz. per bu., presprinkled	94.7	95.9	99	98	98	295	98.3
23. do 2 oz. per bu.	82.8	86.1	95	100	100	295	98.3
24. do 2 oz. per bu., presprinkled	98.5	98.3	90	96	92	278	92.7
25. do 3 oz. per bu.	95.4	96.2	99	98	98	295	98.3
26. do 3 oz. per bu., presprinkled	96.1	96.2	95	85	82	262	87.7
27. Bayer dust, 2 oz. per bu., presprinkled	83.9	84.3	99	100	100	299	99.6
28. do 3 oz. per bu., presprinkled	85.5	86.4	100	100	100	300	100.0
29. Check (no treatment)	49.8	55.5	98	100	99	297	99.0
30. Clean seed (untreated)	88.8	91.1	100	100	99	299	99.6
31. Clean seed, mercuric chloride, (1–1,000), 1½ hrs. soak, presprinkled	91.6	91.4	100	100	99	299	99.6

Table 3 gives in detail the treatments used and results obtained with various amounts of this compound. The highest percentages of control with the dust treatments were obtained when the dust was applied at the rate of 4 ounces per bushel to presprinkled cut seed: 81.1 per cent control by weight, and 80.6 per cent control by number. This did not equal the control obtained with either mercuric chloride or hot formalin, nor the control obtained with Dupont Dust in 1924. All of the tubers in this particular series of treatments, except the checks, were presprinkled before receiving further treat-



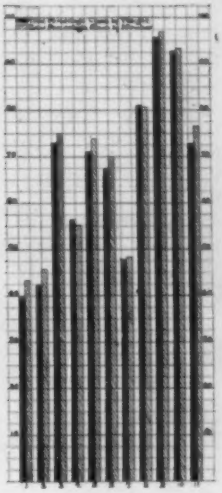


FIG. 3 (Left). Comparison of the average percentages of clean tubers by weight and by number secured by various seed treatments (table 1) for the control of rhizoctonia of potatoes in 1925 at Moscow, Idaho.

FIG. 4 (Right). Comparison of the average percentages of clean tubers by weight and by number secured by treatment with Dupont Dust No. 15 (table 3) for the control of rhizoctonia of potatoes in 1926 at Moscow, Idaho.

ments. The Early Ohio variety of potatoes was used in these tests. Figure 4 gives in a graphic manner the results of this experiment.

EXPERIMENTAL DATA FOR 1926

A somewhat more extensive group of tests was made in 1926, the general procedure of which closely approximated that of former years. More checks, however, were included in the list, as was also a more extensive list of disinfectants.

Each treatment was replicated three times, each replication consisting of 50 seed pieces, of from 2 to 3 ounces in weight, planted in a 60-foot row.

TABLE 3.—*The effectiveness of Dupont dust No. 15 as compared with mercuric chloride and formalin treatments for the control of rhizoctonia of potatoes in 1925 at Moscow, Idaho*

Treatment	Total control in per cent by wt.	Total control in per cent by no.	Marketable tubers								Culls							
			Clean				Diseased				Clean				Diseased			
			Wt.[a]	%	No.	%	Wt.[a]	%	No.	%	Wt.[a]	%	No.	%	Wt.[a]	%	No.	%
1. Check (no treatment)	39.6	43.4	35.0	28.3	132	21.7	57.5	46.6	198	32.5	14.0	11.3	132	21.7	17.0	13.8	147	24.1
2. Dupont dust No. 15, 1 oz. per bu. Cut before treating	42.3	45.8	40.5	29.3	115	18.8	62.5	45.3	182	29.7	18.0	13.0	165	27.0	17.0	12.3	150	24.5
3. Dupont dust No. 15, 1 oz. per bu. Cut after treating	72.9	74.8	91.6	56.0	278	41.2	37.0	22.8	110	16.3	27.5	16.9	227	33.6	7.0	4.3	60	8.9
4. Dupont dust No. 15, 2 oz. per bu. Cut before treating	56.4	55.1	78.0	46.3	215	31.6	59.5	35.3	175	25.7	17.0	10.1	160	23.5	14.0	8.3	130	19.1
5. Dupont dust No. 15, 2 oz. per bu. Cut after treating	71.0	73.8	94.0	54.7	262	35.3	40.0	23.3	110	14.8	28.0	16.3	286	38.5	10.0	5.8	85	11.4
6. Dupont dust No. 15, 3 oz. per bu. Cut before treating	67.3	70.0	89.0	57.6	289	46.0	43.5	28.2	127	20.2	15.0	9.7	151	24.0	7.0	4.5	61	9.7
7. Dupont dust No. 15, 3 oz. per bu. Cut after treating	47.8	48.4	49.0	35.8	157	25.2	54.5	39.8	178	28.5	16.5	12.0	145	23.2	17.0	12.4	144	23.1
8. Dupont dust No. 15, 4 oz. per bu. Cut before treating	81.1	80.6	97.5	67.0	306	50.0	20.5	14.1	58	9.5	20.5	14.1	187	30.6	7.0	4.8	61	9.9
9. Mercuric chloride (1–1,000), 1½ hrs. soak	95.8	97.0	113.0	73.4	319	49.8	5.5	3.6	14	2.2	34.5	22.4	302	47.2	1.0	0.6	5	0.8
10. Formalin (1–120), 55° C., 3 min.	92.6	93.3	101.0	74.2	309	52.8	8.0	5.9	25	4.3	25.0	18.4	237	40.5	2.0	1.5	14	2.4
11. Check (no treatment)	72.8	76.5	58.5	47.6	198	30.8	26.5	21.5	81	12.4	31.0	25.2	294	45.7	7.0	5.7	70	10.9

[a] Weight in lbs.

Tabulation of results was the same as in former years. The Netted Gem variety of potatoes was again used. All tubers were presprinkled.

Table 4 gives the list of treatments, the product of each replication, and percentages of control. In examining table 4 it will be noticed that the best control in 1926 was obtained with formalin, when presprinkled potatoes were dipped in a 1–120 solution, at 125° F., for four minutes.

Figure 5 depicts in a graphic manner the average percentages of control,

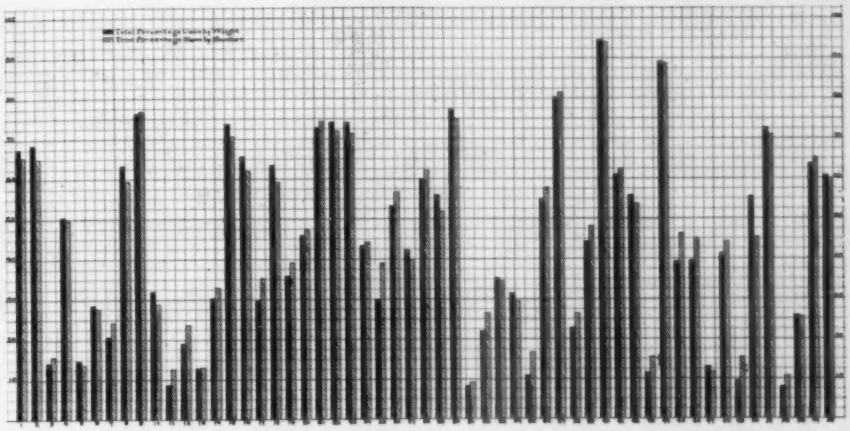


FIG. 5. Comparison of the average percentages of clean tubers by weight and by number secured by various seed treatments (table 4) for the control of rhizoctonia of potatoes in 1926 at Moscow, Idaho.

of the 1926 tests, based on number and on weight. A comparison of the data seems to indicate that percentages of control are comparable when based on either weights or numbers.

DISCUSSION

It would seem desirable to compare more closely results obtained by the same treatment for the various years. With that in mind, table 5 was prepared. The table includes results obtained in 1924, which are already in published form.

In examining the table it will be noticed that the checks reacted quite similarly each year: all three types of checks were most free from infection in 1925, less free in 1924, and least free from infection in 1926. This is not exactly the case with the checks of clean seed treated with mercuric chloride, as the percentage of control with these checks was the same in 1924 and 1926.

The results with tubers treated with mercuric chloride followed the same curve as did the results of the checks for the three years: they were freer from infection in 1925, when the checks were most free; least free in 1926

TABLE 4.—*The effectiveness of various seed treatments in controlling rhizoctonia of potatoes in 1926 at Moscow, Idaho*

Treatment	Plot	Total control in per cent by wt.	Total control in per cent by no.	Marketable tubers								Culls							
				Clean				Diseased				Clean				Diseased			
				Wt.[a]	%	No.	%	Wt.[a]	%	No.	%	Wt.[a]	%	No.	%	Wt.[a]	%	No.	%
1. Check (clean seed)	1	22.8	30.8	12.0	18.9	34	13.8	45.0	70.8	126	51.0	2.5	3.9	42	17.0	4.0	6.3	45	18.2
	2	96.6	96.3	67.0	91.8	162	75.0	2.5	3.4	8	3.7	3.5	4.8	46	21.3	0.0	0.0	0	0.0
	3	78.5	72.9	44.0	67.7	118	46.5	11.0	16.9	32	12.6	7.0	10.8	67	26.4	3.0	4.6	37	14.5
	Ave.	67.5	65.4	41.0	61.1	104.7	43.8	19.5	29.1	55.3	23.1	4.3	6.4	51.6	21.6	2.3	3.4	27.3	11.4
2. Check (clean seed), mercuric chloride (1–1,000), 1½ hrs.	1	19.3	18.1	10.0	16.1	21	9.5	42.0	67.7	104	47.3	2.0	3.2	19	8.6	8.0	12.9	76	34.5
	2	81.1	82.1	54.0	70.6	117	53.7	14.0	18.3	30	13.8	8.0	10.5	62	28.4	0.5	0.7	9	4.1
	3	94.9	96.6	69.0	87.3	161	77.8	4.0	5.1	7	3.4	6.0	7.6	39	18.8	0.0	0.0	0	0.0
	Ave.	68.5	65.0	44.3	61.2	99.7	46.4	20.0	27.6	47.0	21.9	5.3	7.3	40.0	18.6	2.8	3.9	28.3	13.1
3. Check (diseased seed)	1	24.7	28.5	12.5	22.9	29	15.6	36.0	66.1	86	46.2	1.0	1.8	24	12.9	5.0	9.2	47	25.3
	2	9.7	9.9	2.0	2.8	10	4.5	59.5	83.2	149	67.4	5.0	6.9	12	5.4	5.0	6.9	50	22.6
	3	9.0	8.8	3.5	7.0	7	4.4	38.0	76.0	93	58.9	1.0	2.0	7	4.4	7.5	15.0	51	32.3
	Ave.	14.1	15.7	6.0	10.2	15.3	8.1	44.5	75.9	109.3	58.1	2.3	3.9	14.3	7.6	5.8	9.9	49.3	26.2
4. Mercuric chloride (1–1,000), 1½ hrs.	1	15.2	22.1	10.0	14.5	27	12.4	55.5	80.4	125	57.6	0.5	0.7	21	9.7	3.0	4.3	44	20.3
	2	86.0	87.9	61.5	82.0	128	69.9	10.0	13.3	15	8.2	3.0	4.0	33	18.0	0.5	0.7	7	3.8
	3	47.4	45.6	33.0	42.9	83	33.5	35.0	45.5	89	35.9	3.5	4.5	30	12.1	5.5	7.1	46	18.5
	Ave.	50.4	49.6	34.8	47.3	79.3	36.7	33.5	45.5	76.3	35.3	2.3	3.1	28.0	12.9	3.0	4.1	32.3	14.9
5. Semesan Bel, 2 oz. per bu., before cutting	1	2.2	1.8	1.0	1.5	2	0.9	58.0	85.9	137	61.7	0.5	0.7	2	0.9	8.0	11.9	81	36.5
	2	25.4	25.2	14.0	20.3	32	15.2	46.0	66.7	109	51.9	3.5	5.1	21	10.0	5.5	7.9	48	22.9
	3	16.7	14.1	9.0	15.0	19	8.9	45.0	75.0	133	62.7	1.0	1.7	11	5.2	5.0	8.3	49	23.1
	Ave.	14.8	13.7	8.0	12.2	17.7	8.4	49.7	75.8	126.3	59.8	1.7	2.6	11.3	5.3	6.2	9.5	56.0	26.5
6. Semesan Bel, 3 oz. per bu., after cutting	1	23.0	20.9	12.0	19.7	19	9.7	40.0	65.6	95	48.5	2.0	3.3	22	11.2	7.0	11.5	60	30.6
	2	40.5	39.0	23.0	38.0	58	24.1	33.0	54.5	106	43.9	1.5	2.5	36	14.9	3.0	4.9	41	17.0
	3	22.6	20.4	12.5	19.5	29	14.1	44.0	68.8	111	53.9	2.0	3.1	13	6.3	5.5	8.6	53	25.7
	Ave.	28.5	27.6	15.8	25.6	35.3	16.5	39.0	63.1	104.0	48.5	1.8	2.9	23.7	11.1	5.2	8.4	51.3	23.9
7. Semesan Bel, 10% solution, dip	1	9.1	15.5	4.5	8.2	16	8.0	47.0	85.5	122	61.0	0.5	0.9	15	7.5	3.0	5.5	47	23.5
	2	38.6	37.0	26.0	37.9	63	27.4	38.0	55.5	102	44.3	0.5	0.7	22	9.6	4.0	5.8	43	18.7
	3	8.4	17.1	3.0	6.3	10	6.1	38.0	80.0	89	54.6	1.0	2.1	18	11.0	5.5	11.6	46	28.2
	Ave.	20.8	24.3	11.2	19.6	29.7	15.0	41.0	71.8	104.3	52.8	0.7	1.2	18.3	9.3	4.2	7.4	45.3	22.9
8. Check (clean seed)	1	20.2	15.5	11.5	17.9	23	9.9	41.0	64.1	96	41.4	1.5	2.3	13	5.6	10.0	15.6	100	43.1
	2	82.4	76.8	60.0	70.6	132	50.9	13.0	15.3	24	9.3	10.0	11.8	67	25.9	2.0	2.3	36	13.9
	3	80.9	79.1	46.0	73.0	153	54.3	11.0	17.5	39	13.8	5.0	7.9	70	24.8	1.0	1.6	20	7.1
	Ave.	63.2	59.3	39.2	55.4	102.7	39.9	21.7	30.9	53.0	20.6	5.5	7.8	50.0	19.4	4.3	6.1	52.0	20.2

TABLE 4.—(*Continued*)

TABLE 4.—(*Continued*)

Treatment	Plot	Total control in per cent by wt.	Total control in per cent by no.	Marketable tubers								Culls							
				Clean				Diseased				Clean				Diseased			
				Wt.[a]	%	No.	%	Wt.[a]	%	No.	%	Wt.[a]	%	No.	%	Wt.[a]	%	No.	%
9. Check (clean seed), mercuric chloride, (1–1,000), 1½ hrs.	1	35.4	33.9	18.0	32.7	42	22.6	29.0	52.7	63	33.9	1.5	2.7	21	11.3	6.5	11.8	60	32.2
	2	94.9	92.9	71.5	89.9	192	72.2	3.5	4.4	11	4.1	4.0	5.0	55	20.7	0.5	0.6	8	3.0
	3	88.3	93.3	48.0	80.0	113	63.1	7.0	11.7	12	6.7	5.0	8.3	54	30.2	0.0	0.0	0	0.0
	Ave.	76.1	76.8	45.8	70.7	115.7	55.9	13.2	20.4	25.3	12.2	3.5	5.4	43.3	20.9	2.3	3.4	22.7	10.9
10. Check (diseased seed)	1	22.3	16.5	11.0	20.4	20	11.0	34.0	62.9	81	44.7	1.0	1.9	10	5.5	8.0	14.8	70	38.7
	2	38.4	38.7	19.0	30.4	42	18.7	30.5	48.8	69	30.7	5.0	8.0	45	20.0	8.0	12.8	69	30.7
	3	34.3	28.7	17.0	32.4	45	22.3	27.5	52.4	72	35.6	1.0	1.9	13	6.4	7.0	13.3	72	35.6
	Ave.	31.9	28.8	15.7	27.8	35.7	17.6	30.7	54.4	74.0	36.5	2.3	4.1	22.7	11.2	7.7	13.7	70.3	34.7
11. Dupont dust No. 12, 2 oz. per bu., before cutting	1	10.3	22.6	4.0	7.5	14	7.7	43.0	80.4	101	55.8	1.5	2.8	27	14.9	5.0	9.3	39	21.5
	2	13.9	15.6	9.0	13.2	23	9.7	54.0	79.4	141	59.2	0.5	0.7	14	5.9	4.5	6.6	60	25.2
	3	0.9	1.8	0.5	0.9	4	1.8	52.5	93.8	165	72.7	0.0	0.0	0	0.0	3.0	5.4	58	25.6
	Ave.	8.8	12.6	4.5	7.6	13.7	6.4	49.8	84.1	135.7	63.1	0.7	1.2	13.3	6.2	4.2	7.1	52.3	24.3
12. Dupont dust No. 12, 3 oz. per bu., after cutting	1	9.1	17.5	5.0	8.3	21	9.7	53.0	87.6	145	66.8	0.5	0.8	17	7.8	2.0	3.3	34	15.7
	2	33.6	38.8	18.0	28.8	46	20.3	36.5	58.4	79	34.8	3.0	4.8	42	18.5	5.0	8.0	60	26.4
	3	13.2	14.4	7.0	12.7	28	12.2	45.0	81.4	139	60.7	0.3	0.5	5	2.2	3.0	5.4	57	24.9
	Ave.	19.0	23.6	10.0	16.8	31.7	14.1	44.8	75.4	121.0	53.9	1.3	2.2	21.3	9.5	3.3	5.6	50.3	22.4
13. Dupont dust No. 12, 10% solution, dip	1	4.7	2.7	3.0	4.7	5	2.7	54.0	85.0	121	65.1	0.0	0.0	0	0.0	6.5	10.2	60	32.3
	2	4.6	2.4	3.0	4.6	5	2.4	54.0	83.1	130	62.8	0.0	0.0	0	0.0	8.0	12.3	72	34.8
	3	29.1	31.7	17.0	28.3	52	23.9	41.5	69.2	117	53.7	0.5	0.8	17	7.8	1.0	1.7	32	14.7
	Ave.	12.9	13.0	7.7	12.6	20.7	10.2	47.8	78.5	122.7	60.2	0.2	0.3	5.7	2.8	5.2	8.5	54.7	26.8
14. Dupont dust No. 37, 2 oz. per bu., before cutting	1	32.8	31.4	18.5	29.6	50	24.9	38.5	61.6	96	47.8	2.0	3.2	13	6.5	3.5	5.6	42	20.8
	2	29.0	32.8	15.5	23.1	34	17.4	44.0	65.7	99	50.8	4.0	5.9	30	15.4	3.5	5.2	32	16.4
	3	28.7	34.3	12.5	26.6	44	21.6	29.5	62.8	76	37.3	1.0	2.1	26	12.7	4.0	8.5	58	28.4
	Ave.	30.3	32.9	15.5	26.4	42.7	21.4	37.3	63.4	90.3	45.2	2.3	3.9	23.0	11.5	3.7	6.3	44.0	22.0
15. Check (clean seed)	1	78.0	75.8	52.5	70.0	123	55.2	14.0	18.7	32	14.3	6.0	8.0	46	20.6	2.5	3.3	22	9.9
	2	74.5	69.6	40.0	60.2	99	38.9	11.5	17.3	32	12.6	9.5	14.3	78	30.7	5.5	8.2	45	17.7
	3	67.2	65.5	34.0	58.6	76	39.2	18.5	31.9	48	24.7	5.0	8.6	51	26.3	0.5	0.9	19	9.8
	Ave.	73.7	70.5	42.2	63.5	99.3	44.4	14.7	22.1	37.3	16.7	6.8	10.2	58.3	26.1	2.8	4.2	28.7	12.8
16. Check (clean seed), mercuric chloride (1–1,000), 1½ hrs.	1	94.2	90.4	52.0	85.9	107	57.2	3.0	4.9	6	3.2	5.0	8.3	62	33.2	0.5	0.8	12	6.4
	2	100.0	100.0	65.5	91.6	153	75.7	0.0	0.0	0	0.0	6.0	8.4	49	24.3	0.0	0.0	0	0.0
	3	16.4	13.7	11.5	13.5	21	7.8	58.0	67.8	115	42.8	2.5	2.9	16	5.9	13.5	15.8	117	43.5
	Ave.	65.5	62.0	43.0	59.3	93.7	42.7	20.3	28.0	40.3	18.4	4.5	6.2	42.3	19.3	4.7	6.5	43.0	19.6

TABLE 4.—(*Continued*)

Treatment	Plot	Total control in per cent by wt.	Total control in per cent by no.	Marketable tubers								Culls							
				Clean				Diseased				Clean				Diseased			
				Wt.[a]	%	No.	%	Wt.[a]	%	No.	%	Wt.[a]	%	No.	%	Wt.[a]	%	No.	%
17. Check (diseased seed)	1	57.7	57.8	27.5	47.4	61	26.3	19.0	32.8	47	20.3	6.0	10.3	73	31.5	5.5	9.5	51	21.9
	2	31.8	33.3	16.0	29.1	46	22.9	34.0	61.8	95	47.3	1.5	2.7	21	10.4	3.5	6.4	39	19.4
	3	1.6	2.7	1.0	1.6	4	2.7	58.5	90.7	62	41.9	0.0	0.0	0	0.0	5.0	7.7	82	55.4
	Ave.	29.6	35.3	14.8	24.9	37.0	19.1	37.2	62.5	68.0	35.1	2.8	4.7	31.3	16.2	4.7	7.9	57.3	29.6
18. Dupont dust No. 37, 3 oz. per bu., after cutting	1	75.7	74.3	42.0	64.9	91	43.9	14.5	22.4	35	16.9	7.0	10.8	63	30.4	1.3	1.9	18	8.7
	2	85.8	85.4	56.0	82.9	130	63.1	9.0	13.3	24	11.7	2.0	2.9	46	22.3	0.5	0.7	6	2.9
	3	32.5	23.6	21.5	29.1	41	17.0	41.0	55.4	96	39.8	2.5	3.4	16	6.6	9.0	12.2	88	36.5
	Ave.	63.4	59.1	39.8	57.9	87.3	40.0	21.5	31.3	51.7	23.7	3.8	5.5	41.7	19.1	3.6	5.2	37.3	17.1
19. Dupont dust No. 37, 10% solution, dip	1	45.2	53.2	22.0	38.3	59	27.3	27.5	47.8	62	28.7	4.0	6.9	56	25.9	4.0	6.9	39	18.1
	2	57.2	61.2	32.5	48.9	83	38.8	27.0	40.6	72	33.6	5.5	8.3	48	22.4	1.5	2.3	11	5.1
	3	5.4	5.6	3.5	5.4	11	4.7	53.0	82.2	133	57.3	Tr.	Tr.	2	0.9	8.0	12.4	86	37.0
	Ave.	35.8	39.1	19.3	30.7	51.0	23.1	35.8	57.0	89.0	40.3	3.2	5.1	35.3	16.0	4.5	7.2	45.3	20.5
20. Semesan, 2 oz. per bu., before cutting	1	56.4	56.6	38.5	46.7	83	39.5	28.0	33.9	55	26.2	8.0	9.7	36	17.1	8.0	9.7	36	17.1
	2	59.4	61.7	31.0	58.5	83	46.1	21.0	39.6	51	28.3	0.5	0.9	28	15.6	0.5	0.9	18	10.0
	3	26.3	30.0	19.0	23.8	45	17.3	53.0	66.3	120	46.2	2.0	2.5	33	12.7	6.0	7.5	62	23.8
	Ave.	45.9	47.4	29.5	41.1	70.3	32.5	34.0	47.4	75.3	34.8	3.5	4.8	32.3	14.9	4.8	6.7	38.7	17.9
21. Semesan, 3 oz. per bu., after cutting	1	100.0	100.0	51.0	91.1	120	56.9	0.0	0.0	0	0.0	5.0	8.9	91	43.1	0.0	0.0	0	0.0
	2	100.0	100.0	42.0	93.3	82	74.5	0.0	0.0	0	0.0	3.0	6.7	28	25.5	0.0	0.0	0	0.0
	3	20.4	30.1	10.0	18.5	27	14.5	38.0	70.3	77	41.4	1.0	1.9	29	15.6	5.0	9.3	53	28.5
	Ave.	72.7	74.3	34.3	66.9	76.3	45.1	12.3	23.9	25.7	15.2	3.0	5.8	49.3	29.2	1.7	3.3	17.7	10.4
22. Check (clean seed)	1	93.0	90.4	62.0	77.9	137	54.8	5.0	6.3	16	6.4	12.0	15.1	89	35.6	0.5	0.6	8	3.2
	2	86.8	85.7	36.0	67.9	90	41.5	6.0	11.3	15	6.9	10.0	18.9	96	44.2	1.0	1.9	16	7.4
	3	45.7	39.1	32.0	41.8	61	26.8	35.0	45.8	74	32.5	3.0	3.9	28	12.3	6.5	8.5	65	28.5
	Ave.	74.1	72.0	43.3	62.2	96.0	41.4	15.3	21.9	35.0	15.1	8.3	11.9	71.0	30.6	2.7	3.9	29.7	12.8
23. Check (clean seed), mercuric chloride (1–1,000), 1½ hrs.	1	100.0	100.0	54.0	78.8	119	51.9	0.0	0.0	0	0.0	14.5	21.2	110	48.0	0.0	0.0	0	0.0
	2	73.8	73.5	43.0	70.5	123	63.7	13.0	21.3	21	10.9	2.0	3.3	19	9.8	3.0	4.9	30	15.5
	3	46.3	39.5	29.0	45.9	83	37.7	31.0	49.0	87	39.5	0.3	0.4	4	1.8	3.0	4.7	46	20.9
	Ave.	74.0	71.3	42.0	65.3	108.3	50.6	14.7	22.9	36.0	16.8	5.6	8.7	44.3	20.7	2.0	3.1	25.3	11.8
24. Check (diseased seed)	1	18.0	22.7	10.5	17.2	26	13.4	47.0	77.0	109	56.2	0.5	0.8	18	9.3	3.0	4.9	41	21.1
	2	54.2	57.5	25.0	45.9	57	34.5	21.0	38.5	44	26.7	4.5	8.3	38	23.0	4.0	7.3	26	15.8
	3	63.8	56.9	27.0	57.4	57	37.7	13.0	27.7	34	22.5	3.0	6.4	29	19.2	4.0	8.5	31	20.5
	Ave.	43.3	44.1	20.8	38.4	46.7	27.5	27.0	49.8	62.3	36.6	2.7	4.9	28.3	16.6	3.7	6.8	32.7	19.2

TABLE 4.—(*Continued*)

TABLE 4.—(*Continued*)

Treatment	Plot	Total control in per cent by wt.	Total control in per cent by no.	Marketable tubers								Culls							
				Clean				Diseased				Clean				Diseased			
				Wt.[a]	%	No.	%	Wt.[a]	%	No.	%	Wt.[a]	%	No.	%	Wt.[a]	%	No.	%
25. Bayer dust, 2 oz. per bu., before cutting	1	38.3	50.7	21.0	29.8	44	18.3	40.0	56.7	91	37.8	6.0	8.5	78	32.4	3.5	4.9	28	11.6
	2	52.1	54.0	22.5	46.9	59	31.2	20.0	41.7	52	27.5	2.5	5.2	43	22.8	3.0	6.3	35	18.5
	3	4.9	9.8	3.0	4.5	14	7.2	60.0	90.6	131	67.5	0.3	0.4	5	2.6	3.0	4.5	44	22.7
	Ave.	29.9	39.0	15.5	25.2	39.0	18.8	40.0	64.9	91.3	43.9	2.9	4.7	42.0	20.2	3.2	5.2	35.7	17.2
26. Bayer dust, 3 oz. per bu., after cutting	1	58.4	62.1	38.5	47.8	84	30.7	30.0	37.3	68	24.8	8.5	10.6	86	31.4	3.5	4.3	36	13.1
	2	70.3	70.2	38.0	69.4	99	61.5	16.0	29.2	43	26.7	0.5	0.9	14	8.7	0.3	0.5	5	3.1
	3	34.5	38.6	24.0	33.1	64	30.9	44.5	61.4	97	46.9	1.0	1.4	16	7.7	3.0	4.1	30	14.5
	Ave.	53.1	56.6	33.5	48.3	82.3	38.5	30.2	43.6	69.3	32.4	3.3	4.8	38.7	18.1	2.3	3.3	23.7	11.1
27. Colloidal copper, 2 oz. per bu., before cutting	1	71.2	61.7	29.5	67.8	63	38.9	11.0	25.3	34	20.9	1.5	3.4	37	22.8	1.5	3.4	28	17.3
	2	22.7	25.0	3.5	15.9	8	10.5	14.0	63.6	34	44.7	1.5	6.8	11	14.5	3.0	13.6	23	30.3
	3	30.6	30.3	21.0	29.2	54	20.7	47.0	65.3	131	50.2	1.0	1.4	25	9.6	3.0	4.2	51	19.5
	Ave.	42.1	39.7	18.0	39.3	41.7	25.1	24.0	52.4	66.3	39.9	1.3	2.8	24.3	14.6	2.5	5.5	34.0	20.4
28. Colloidal copper, 3 oz. per bu., after cutting	1	70.3	71.3	28.0	69.1	60	52.2	12.0	29.6	33	28.7	0.5	1.2	22	19.1	0.0	0.0	0	0.0
	2	23.0	36.0	2.5	19.2	9	14.1	9.5	73.1	24	37.5	0.5	3.8	14	21.9	0.5	3.8	17	26.6
	3	61.5	69.8	15.5	59.6	35	46.1	10.0	38.5	19	25.0	0.5	1.9	18	23.7	Tr.	Tr.	4	5.3
	Ave.	59.6	62.0	15.3	57.7	34.7	40.8	10.5	39.6	25.3	29.8	0.5	1.9	18.0	21.2	0.2	0.8	7.0	8.2
29. Check (clean seed)	1	81.3	78.1	55.0	76.4	126	52.1	13.0	18.1	41	16.9	3.5	4.9	63	26.0	0.5	0.7	12	4.9
	2	8.3	9.7	6.0	8.3	23	9.7	62.0	85.5	146	61.9	0.0	0.0	0	0.0	4.5	6.2	67	28.4
	3	67.5	63.7	59.0	64.8	150	49.8	26.5	29.1	65	21.6	2.5	2.7	42	13.9	3.0	3.3	44	14.6
	Ave.	55.9	51.9	40.0	53.2	99.7	38.4	30.5	40.6	84.0	32.3	2.0	2.7	35.0	13.5	2.7	3.6	41.0	15.8
30. Check (clean seed), mercuric chloride (1–1,000), 1½ hrs.	1	99.0	99.6	66.0	85.2	127	53.4	0.0	0.0	0	0.0	11.5	14.8	110	46.2	Tr.	Tr.	1	0.4
	2	30.9	26.6	18.5	30.5	44	24.4	41.0	67.5	114	63.3	0.3	0.4	4	2.2	1.0	1.6	18	10.0
	3	92.8	87.0	61.0	87.1	143	63.8	3.0	4.3	10	4.5	4.0	5.7	52	23.2	2.0	2.9	19	8.5
	Ave.	77.1	74.7	48.5	69.5	104.7	48.9	15.0	21.5	41.3	19.3	5.3	7.6	55.3	25.8	1.0	1.4	12.7	5.9
31. Check (diseased seed)	1	13.2	10.6	5.5	10.4	9	5.3	38.0	71.7	82	48.2	1.5	2.8	9	5.3	8.0	15.1	70	41.2
	2	8.3	10.8	5.0	7.9	19	7.9	55.0	87.6	166	68.6	0.3	0.4	7	2.9	2.5	3.9	50	20.7
	3	4.6	6.0	3.0	4.2	7	3.0	61.0	85.6	146	62.9	0.3	0.4	7	3.0	7.0	9.8	72	31.0
	Ave.	8.3	9.1	4.5	7.2	11.7	5.5	51.3	82.3	131.3	61.2	0.7	1.1	7.7	3.6	5.8	9.3	64.0	29.8
32. Colloidal copper, 1% solution, dip	1	42.6	44.4	23.0	40.0	62	25.5	31.0	53.9	88	36.2	1.5	2.6	46	18.9	2.0	3.5	47	19.3
	2	9.5	8.7	5.0	7.9	8	4.1	50.5	80.1	122	62.6	1.0	1.6	9	4.6	6.5	10.3	56	28.7
	3	16.1	21.9	9.5	13.9	20	10.2	51.0	75.0	97	49.2	1.5	2.2	23	11.7	6.0	8.8	57	28.9
	Ave.	22.0	26.5	12.5	19.9	30.0	14.2	44.2	70.4	102.3	48.3	1.3	2.1	26.0	12.3	4.8	7.6	53.3	25.2

TABLE 4.—(*Continued*)

Treatment	Plot	Total control in per cent by wt.	Total control in per cent by no.	Marketable tubers								Culls							
				Clean				Diseased				Clean				Diseased			
				Wt.[a]	%	No.	%	Wt.[a]	%	No.	%	Wt.[a]	%	No.	%	Wt.[a]	%	No.	%
33. Potassium permanganate, 2% solution, dip	1	54.7	55.3	36.5	45.9	76	30.9	29.0	36.5	59	23.9	7.0	8.8	60	24.4	7.0	8.8	51	20.7
	2	9.5	6.6	7.0	9.5	15	6.6	56.5	76.9	133	58.3	0.0	0.0	0	0.0	10.0	13.6	80	35.1
	3	39.7	39.3	25.9	33.1	56	22.0	38.0	50.3	92	36.2	5.0	6.6	44	17.3	7.5	9.9	62	24.4
	Ave.	35.1	34.5	22.8	29.9	49.0	20.2	41.2	54.1	94.7	39.0	4.0	5.2	34.7	14.3	8.2	10.8	64.3	26.5
34. Potassium permanganate, 5% solution, dip	1	64.5	59.4	41.0	56.9	91	38.9	21.5	29.9	52	22.2	5.5	7.6	48	20.5	4.0	5.6	43	18.4
	2	10.4	10.2	6.5	9.7	11	5.9	52.0	77.6	111	59.0	0.5	0.7	8	4.3	8.0	11.9	58	30.9
	3	18.5	16.5	12.0	17.8	36	13.5	47.0	69.6	139	52.3	0.5	0.7	8	3.0	8.0	11.9	83	31.2
	Ave.	31.9	29.4	19.8	28.7	46.0	20.1	40.2	58.3	100.7	43.9	2.2	3.2	21.3	9.3	6.7	9.7	61.3	26.7
35. Dupont dust No. 15, 2 oz. per bu., before cutting	1	18.1	29.2	7.0	11.5	23	9.7	42.0	68.9	98	41.5	4.0	6.6	46	19.5	8.0	13.1	69	29.2
	2	8.7	11.3	5.0	8.3	11	5.9	48.0	79.7	120	65.2	0.3	0.4	10	5.4	7.0	11.6	43	23.4
	3	5.6	6.8	3.0	5.2	9	4.4	51.0	89.1	146	70.9	0.3	0.4	5	2.4	3.0	5.2	46	22.3
	Ave.	10.9	16.6	5.0	8.4	14.3	6.9	47.0	78.9	121.3	58.1	1.5	2.5	20.3	9.7	6.0	10.1	52.7	25.3
36. Check (clean seed)	1	92.7	85.7	47.5	87.2	142	58.2	3.5	6.4	18	7.4	3.0	5.5	67	27.5	0.5	0.9	17	6.9
	2	13.1	12.2	7.0	10.8	14	7.1	50.0	76.9	122	61.6	1.5	2.3	10	5.1	6.5	10.0	52	26.3
	3	65.4	67.6	37.5	59.1	99	42.9	18.0	28.3	32	13.9	4.0	6.3	57	24.7	4.0	6.3	43	18.6
	Ave.	54.9	57.8	30.7	50.3	85.0	37.9	23.8	39.0	57.3	25.5	2.8	4.6	44.7	19.9	3.7	6.1	37.3	16.6
37. Check (clean seed), mercuric chloride (1–1,000), 1½ hrs.	1	89.8	92.5	51.0	80.3	104	55.9	3.0	4.7	10	5.4	9.5	14.9	68	36.6	Tr.	Tr.	4	2.2
	2	99.6	98.6	68.0	95.4	175	79.5	0.2	0.4	2	0.9	3.0	4.2	42	19.1	Tr.	Tr.	1	0.5
	3	45.5	45.7	29.0	43.3	57	34.8	34.0	50.7	71	43.3	1.5	2.2	18	10.9	2.5	3.7	18	10.9
	Ave.	80.3	81.4	49.3	73.4	112.0	58.9	12.4	18.5	27.7	14.6	4.7	6.9	42.7	22.5	0.8	1.2	7.7	4.0
38. Check (diseased seed)	1	32.4	34.6	12.5	25.3	31	15.3	26.5	53.5	70	34.7	3.5	7.1	39	19.3	7.0	14.1	62	30.7
	2	10.8	22.2	7.0	10.1	22	11.6	57.5	82.7	106	56.1	0.5	0.7	20	10.6	4.5	6.5	41	21.7
	3	29.1	22.4	17.0	28.7	44	20.1	39.0	65.8	120	54.8	0.3	0.4	5	2.3	3.0	5.1	50	22.8
	Ave.	22.8	26.4	12.2	20.5	32.3	15.9	41.0	69.0	98.7	48.5	1.4	2.3	21.3	10.5	4.8	8.1	51.0	25.1
39. Dupont dust No. 15, 3 oz. per bu., after cutting	1	65.4	63.8	35.5	54.6	63	33.5	20.0	30.8	40	21.3	7.0	10.8	57	30.3	2.5	3.8	28	14.9
	2	22.0	31.7	12.5	17.7	30	15.6	51.0	72.3	103	53.6	3.0	4.3	31	16.1	4.0	5.7	28	14.6
	3	47.3	49.0	31.0	45.8	75	39.5	35.0	51.7	84	44.2	1.0	1.5	18	9.5	0.7	1.1	13	6.8
	Ave.	44.3	48.1	26.3	38.8	56.0	29.5	35.3	52.1	75.7	39.8	3.7	5.5	35.3	18.6	2.4	3.5	23.0	12.1
40. Formalin (1–120), 125° F., 4 min.	1	100.0	100.0	30.0	83.3	73	56.6	0.0	0.0	0	0.0	6.0	16.7	56	43.4	0.0	0.0	0	0.0
	2	92.0	89.1	57.0	91.2	132	80.0	5.0	8.0	18	10.9	0.5	0.8	15	9.1	0.0	0.0	0	0.0
	3	93.7	94.2	34.5	78.9	78	56.5	2.5	5.7	5	3.6	6.5	14.8	52	37.7	0.3	0.6	3	2.2
	Ave.	94.5	94.0	40.5	85.4	94.3	65.5	2.5	5.2	7.7	5.3	4.3	9.1	41.0	28.5	0.1	0.2	1.0	0.7

TABLE 4.—(*Continued*)

TABLE 4.—(*Continued*)

Treatment	Plot	Total control in per cent by wt.	Total control in per cent by no.	Marketable tubers								Culls							
				Clean				Diseased				Clean				Diseased			
				Wt.[a]	%	No.	%	Wt.[a]	%	No.	%	Wt.[a]	%	No.	%	Wt.[a]	%	No.	%
41. Special dust No. 90, 2 oz. per bu., before cutting	1	94.5	92.4	28.0	77.8	68	47.6	2.0	5.6	6	4.2	6.0	16.7	64	44.8	Tr.	Tr.	5	3.5
	2	50.0	44.7	36.5	48.7	74	38.9	36.5	48.7	75	39.5	1.0	1.3	11	5.8	1.0	1.3	30	15.8
	3	53.1	55.5	25.0	52.6	74	50.7	22.0	46.3	55	37.7	0.3	0.5	7	4.8	0.3	0.5	10	6.8
	Ave.	60.9	62.2	29.8	56.4	72.0	45.1	20.2	38.3	45.3	28.4	2.4	4.5	27.3	17.1	0.4	0.8	15.0	9.4
42. Special dust No. 90, 3 oz. per bu., after cutting	1	12.1	8.6	7.5	10.7	14	7.1	57.0	81.4	132	66.7	1.0	1.4	3	1.5	4.5	6.4	49	24.7
	2	79.8	82.6	43.5	76.3	84	58.3	10.0	17.5	18	12.5	3.0	5.3	35	24.3	0.5	0.9	7	4.9
	3	84.9	81.7	46.0	84.0	120	71.0	8.0	14.6	24	14.2	0.5	0.9	18	10.7	0.3	0.5	7	4.1
	Ave.	55.8	53.6	32.3	53.3	72.7	42.7	25.0	41.3	58.0	34.0	1.5	2.5	18.7	10.9	1.8	2.9	21.0	12.3
43. Check (clean seed)	1	4.1	14.1	2.0	3.3	9	3.9	49.0	80.9	113	50.0	0.5	0.8	23	10.2	9.0	14.9	81	35.8
	2	18.5	22.5	10.5	16.9	32	15.3	48.5	78.2	133	63.6	1.0	1.6	15	7.2	2.0	3.2	29	13.9
	3	13.3	11.0	7.0	13.3	26	10.2	36.5	69.5	106	41.4	Tr.	Tr.	2	0.8	9.0	17.1	122	47.7
	Ave.	12.0	15.5	6.5	11.1	22.3	9.7	44.7	76.5	117.3	50.9	0.5	0.9	13.3	5.8	6.7	11.5	77.3	33.6
44. Check (clean seed), mercuric chloride (1–1,000), 1½ hrs.	1	100.0	100.0	63.5	85.8	179	66.3	0.0	0.0	0	0.0	10.5	14.2	91	33.7	0.0	0.0	0	0.0
	2	82.3	82.1	60.0	80.3	162	68.9	13.0	17.4	38	16.2	1.5	2.0	31	13.2	0.3	0.3	4	1.7
	3	85.6	82.3	59.0	82.8	154	64.7	10.0	14.0	34	14.3	2.0	2.8	42	17.6	0.3	0.4	8	3.4
	Ave.	89.2	88.7	60.8	82.8	165.0	66.6	7.7	10.5	24.0	9.7	4.7	6.4	54.7	22.1	0.2	0.3	4.0	1.6
45. Check (diseased seed)	1	79.1	81.1	38.5	57.5	130	39.6	11.5	17.2	35	10.7	14.5	21.6	136	41.5	2.5	3.7	27	8.2
	2	16.1	11.9	10.0	15.3	18	8.6	46.0	70.2	106	50.5	0.5	0.8	7	3.3	9.0	13.7	79	37.6
	3	14.9	21.9	6.0	12.8	26	14.6	38.0	80.9	93	52.2	1.0	2.1	13	7.3	2.0	4.2	46	25.8
	Ave.	39.3	46.1	18.2	30.4	58.0	24.3	31.8	53.2	78.0	32.7	5.3	8.9	52.0	21.8	4.5	7.5	50.7	21.2
46. Special dust No. 90, 10% solution, dip	1	13.4	20.5	9.0	12.1	25	9.7	61.0	81.9	164	63.3	1.0	1.3	28	10.8	3.5	4.7	42	16.2
	2	68.3	74.7	47.0	67.6	126	64.9	22.0	31.7	49	25.3	0.5	0.7	19	9.8	0.0	0.0	0	0.0
	3	38.9	46.9	27.0	36.2	71	33.0	44.0	59.1	92	42.8	2.0	2.7	30	13.9	1.5	2.0	22	10.2
	Ave.	39.5	44.7	27.7	37.9	74.0	33.2	42.3	58.0	101.7	45.7	1.2	1.6	25.7	11.5	1.7	2.3	21.3	9.6
47. Special dust No. 89, 2 oz. per bu., before cutting	1	3.5	2.8	2.0	2.8	3	1.2	61.5	85.4	156	62.2	0.5	0.7	4	1.6	8.0	11.1	88	35.1
	2	22.8	16.6	16.0	21.8	32	14.0	47.5	64.8	118	51.8	0.8	1.0	6	2.6	9.0	12.3	72	31.6
	3	12.6	16.7	7.0	12.2	27	12.9	48.0	83.8	124	59.0	0.3	0.4	8	3.8	2.0	3.5	51	24.3
	Ave.	13.0	11.6	8.3	12.3	20.7	9.0	52.3	77.6	132.7	57.8	0.5	0.7	6.0	2.6	6.3	9.3	70.3	30.6
48. Special dust No. 89, 3 oz. per bu., after cutting	1	14.9	22.7	9.0	13.4	21	9.9	55.0	82.1	134	63.5	1.0	1.5	27	12.8	2.0	3.0	29	13.7
	2	60.6	55.6	38.0	57.6	86	38.6	21.0	31.8	54	24.2	2.0	3.0	38	17.0	5.0	7.6	45	20.2
	3	47.9	51.8	32.0	45.1	84	33.2	34.0	47.9	79	31.2	2.0	2.8	47	18.6	3.0	4.2	43	16.9
	Ave.	41.2	44.1	26.3	38.7	63.7	27.8	36.7	53.9	89.0	38.9	1.7	2.5	37.3	16.3	3.3	4.9	39.0	17.0

TABLE 4.—(*Concluded*)

Treatment	Plot	Total control in per cent by wt.	Total control in per cent by no.	Marketable tubers								Culls							
				Clean				Diseased				Clean				Diseased			
				Wt.[a]	%	No.	%	Wt.[a]	%	No.	%	Wt.[a]	%	No.	%	Wt.[a]	%	No.	%
49. Special dust No. 89, 10% solution, dip	1	16.2	24.6	8.0	11.3	21	9.4	51.0	71.8	104	46.6	3.5	4.9	34	15.2	8.5	11.9	64	28.7
	2	0.8	3.5	0.5	0.8	6	3.0	52.0	86.7	123	61.8	Tr.	Tr.	1	0.5	7.5	12.5	69	34.7
	3	10.3	17.1	5.5	8.7	15	7.8	51.5	81.1	109	56.5	1.0	1.6	18	9.3	5.5	8.7	51	26.4
	Ave.	9.5	15.4	4.7	7.2	14.0	6.8	51.5	79.4	112.0	54.6	1.5	2.3	17.7	8.6	7.2	11.1	61.3	29.9
50. Check (clean seed)	1	31.7	27.6	19.0	30.9	41	19.5	34.0	55.3	86	40.9	0.5	0.8	17	8.1	8.0	13.0	66	31.4
	2	80.8	76.7	52.0	80.0	146	64.0	12.0	18.5	39	17.1	0.5	0.8	29	12.7	0.5	0.8	14	6.1
	3	68.5	59.3	36.0	64.9	88	38.1	14.5	26.1	45	19.5	2.0	3.6	49	21.2	3.0	5.4	49	21.2
	Ave.	60.4	55.3	35.7	58.8	91.7	41.1	20.2	33.3	56.7	25.4	1.0	1.6	31.7	14.2	3.8	6.3	43.0	19.3
51. Check (clean seed), mercuric chloride (1–1,000), 1½ hrs.	1	28.7	29.6	17.0	27.9	44	24.6	40.5	66.4	88	49.2	0.5	0.8	9	5.0	3.0	4.9	38	21.2
	2	92.4	91.0	59.0	85.2	137	67.8	5.0	7.2	14	6.9	5.0	7.2	47	23.2	0.3	0.4	4	1.9
	3	95.6	87.8	47.0	81.7	101	51.3	2.0	3.5	5	2.5	8.0	13.9	72	36.5	0.5	0.9	19	9.6
	Ave.	72.6	71.0	41.0	65.5	94.0	48.8	15.8	25.2	35.7	18.5	4.5	7.1	42.7	22.2	1.3	2.1	20.3	10.5
52. Check (diseased seed)	1	17.6	23.0	6.0	9.6	15	6.4	43.5	69.6	110	46.8	5.0	8.0	39	16.6	8.0	12.8	71	30.2
	2	2.1	3.1	1.5	2.1	7	3.1	61.0	84.1	139	61.5	0.0	0.0	0	0.0	10.0	13.8	80	35.4
	3	4.2	4.1	2.0	4.2	7	4.1	40.0	83.3	91	53.5	0.0	0.0	0	0.0	6.0	12.5	72	42.4
	Ave.	8.0	10.8	3.2	5.2	9.7	4.6	48.2	78.9	113.3	53.9	1.7	2.8	13.0	6.2	8.0	13.1	74.3	35.3
53. Dupont dust No. 62, 2 oz. per bu., before cutting	1	44.3	44.1	11.0	31.4	33	18.2	11.5	32.9	30	16.6	4.5	12.9	47	25.9	8.0	22.9	71	39.2
	2	24.7	25.7	12.0	23.8	37	17.6	36.0	71.3	120	57.1	0.5	0.9	17	8.1	2.0	3.9	36	17.1
	3	14.2	10.5	7.0	13.7	21	9.2	42.0	81.9	134	58.8	0.3	0.5	3	1.3	2.0	3.9	70	30.7
	Ave.	25.8	25.5	10.0	21.9	30.3	14.7	29.8	65.4	94.7	45.9	1.8	3.9	22.3	10.8	4.0	8.8	59.0	28.6
54. Dupont dust No. 62, 3 oz. per bu., after cutting	1	68.5	66.1	21.5	58.9	65	30.7	11.0	30.1	46	21.7	3.5	9.6	75	35.4	0.5	1.4	26	12.3
	2	71.8	74.5	23.0	64.8	77	53.1	9.0	25.4	25	17.2	2.5	7.0	31	21.4	1.0	2.8	12	8.3
	3	56.8	57.7	33.0	49.3	74	35.9	26.0	38.8	57	27.7	5.0	7.5	45	21.8	3.0	4.5	30	14.6
	Ave.	63.6	65.2	25.8	55.7	72.0	38.4	15.3	33.0	42.7	22.7	3.7	7.9	50.3	26.8	1.5	3.2	22.7	12.1
55. Dupont dust No. 62, 10% solution, dip	1	81.6	83.2	44.0	73.3	114	49.1	10.0	16.7	28	12.1	5.0	8.3	79	34.1	1.0	1.7	11	4.7
	2	70.0	68.7	26.0	52.0	66	33.8	11.5	23.0	31	15.9	9.0	18.0	68	34.9	3.5	7.0	30	15.4
	3	22.2	25.4	9.5	21.1	28	13.7	31.0	68.9	96	46.8	0.5	1.1	24	11.7	4.0	8.9	57	27.8
	Ave.	60.7	60.0	26.5	51.4	69.3	32.9	17.5	33.9	51.7	24.5	4.8	9.3	57.0	27.1	2.8	5.4	32.7	15.5

[a] Weight in lbs.

when the checks were least free; and the results in 1924 were intermediate. Furthermore, very poor control was obtained with this disinfectant in 1926.

The fact that the results obtained with mercuric chloride approximated the same curve as the results of the checks might be expected. However, it might be assumed that the only criterion in determining the amount of soil infestation is the amount of disease which develops when treated clean seed is planted. But one will note (table 5, treatment 29) that approximately 25 per cent of the potatoes grown in infested soil in 1926 were infected. If the above assumption is correct, one would have to concede that the treatment given this check was absolute in controlling any infection from the organism on the seed. If this same treatment gave absolute control of infected seed, then any lot of treated diseased seed might be expected to produce approximately the same percentage of clean product as clean seed treated in like manner. This is not the case, as one will see by glancing at treatment 12 in table 5. Theoretically, then, the difference between the percentages of the clean product of treatment 12 and treatment 29 (1926) should indicate the difference in effectiveness of the two treatments or a lack of uniformity in soil infestation. The latter is in all probability the case, for treatment 12 is the result of but one trial replicated three times, while treatment 29 is the average of eight trials, each replicated three times.

The opposite may be true for the hot formalin (treatment 8). Although this disinfectant produced the highest percentage of control in 1926, it, like treatment 12, is the result of but one trial replicated three times. There is one outstanding fact concerning hot formalin, however, which is not exhibited by the other disinfectants, and that is, that regardless of what results the treated checks produced, the results obtained with hot formalin were quite uniform for the three years' trials.

Results obtained with Dupont Dust No. 15 were not uniform. The disinfectant used in the three years' trials came from the same container. Best control was obtained with it in 1924 and poorest in 1926.

Semesan Dust was like mercuric chloride in the manner in which it followed the same curve as the checks. Excellent control was obtained with it in 1925, but the results obtained in 1926 where not good enough to warrant its use. It is evident, therefore, that more tests will have to be conducted before any definite recommendations can be made in respect to these proprietary disinfectants.

In conclusion the authors wish to explain their reason for reading the results from the standpoint of sclerotia upon the surfaces of the tubers, and not from the standpoint of stem lesions. In the Palouse district in the vicinity of Moscow, Idaho, very few stem lesions ordinarily develop. Very seldom is a poor stand due to *Corticium vagum* var. *solani* Burt., and rarely can aerial tubers, due to the same cause, be found. The authors do not

TABLE 5.—*Comparison of various disinfectants used for more than one year in controlling rhizoctonia of potatoes at Moscow, Idaho*

Treatment	1924 Clean tubers in per cent by		1925 Clean tubers in per cent by		1926 Clean tubers in per cent by	
	wt.	no.	wt.	no.	wt.	no.
1. Check, diseased seed, no treatment	31.7[a]	30.3[a]	46.8[a]	51.4[a]	24.7[b]	27.0[b]
2. Formalin (1–240), 1½ hrs. soak	23.6	23.3	83.4	84.3		
3. do, presprinkled	40.2	41.3	84.4	86.6		
4. Formalin (1–120), 50° C., 4 min.	78.9	78.7	74.3	75.5		
5. do, presprinkled	82.7	80.5	81.3	84.0		
6. Formalin (1–120), 55° C., 4 min.	71.6	73.9	84.3	83.4		
7. do, presprinkled	87.6	86.8	86.2	87.9		
8. Formalin (1–120), presprinkled, 125° F., 4 min.					94.5	94.0
9. Furfural (1–60), 50° C., 10 min.	82.3	76.4	89.3	89.0		
10. do, presprinkled	79.6	78.3	88.7	90.4		
11. Mercuric chloride, (1–1,000), 1½ hrs. soak	74.9	76.3	92.8	91.8		
12. do, presprinkled	88.8	88.0	92.9	93.5	50.4	49.6
13. Dupont dust No. 15, 3 oz. per bu., before cutting	57.8	59.8	55.5	58.8		
14. do, presprinkled	90.3	90.3	65.7	66.3		
15. Dupont dust No. 15, presprinkled, 2 oz. per bu., before cutting			57.0	59.4	10.9	16.6
16. Dupont dust No. 15, presprinkled, 3 oz. per bu., after cutting					44.3	48.1
17. Dupont dust No. 12, 0.1666% solution, 1½ hrs. soak	42.5	46.3				
18. do, presprinkled	32.9	34.4				
19. Dupont dust No. 12, presprinkled, 2 oz. per bu., before cutting					8.8	12.6
20. Dupont dust No. 12, presprinkled, 3 oz. per bu., after cutting					19.0	23.6
21. Dupont dust No. 12, presprinkled, 10% solution, dip					12.9	13.0
22. Semesan dust, 3 oz. per bu., before cutting	68.7	69.2	95.4	96.2		
23. do, presprinkled	81.4	80.9	96.1	96.2		
24. Semesan dust, presprinkled, 2 oz. per bu., before cutting			98.5	98.3	45.9	47.4

TABLE 5.—(*Continued*)

Treatment	1924		1925		1926	
	Clean tubers in per cent by		Clean tubers in per cent by		Clean tubers in per cent by	
	wt.	no.	wt.	no.	wt.	no.
25. Semesan dust, presprinkled, 3 oz. per bu., after cutting					72.7	74.3
26. Semesan dust, 0.125% solution, 1½ hrs. soak	56.5	58.0				
27. do, presprinkled	60.6	60.4				
28. Check (clean seed)	67.3	70.9	88.8	91.1	57.7[b]	55.9[b]
29. Check (clean seed), mercuric chloride, presprinkled (1–1,000), 1½ hrs. soak	74.0	72.9	91.6	91.4	75.4[b]	73.8[b]
30. Bayer dust, presprinkled, 2 oz. per bu., before cutting			83.9	84.3	29.9	39.0
31. Bayer dust, presprinkled, 3 oz. per bu., before cutting			85.5	86.4		
32. do, after cutting					53.1	56.6

[a] Average of two checks.

[b] Average of eight checks.

claim that such symptoms do not occur, but that when they do they are the exception and not the general rule. We offer the following data in explanation of this. The average rainfall in inches during the growing months for the past 35 years is as follows:

May	June	July	August	September	October
2.16	1.37	0.64	0.79	1.22	1.61

The average temperatures in degrees Fahrenheit for the same period are as follows:

May	June	July	August	September	October
52.0	58.6	66.6	66.2	57.4	48.3

The plots are planted about June 1 of each year, and harvested between October 1 and 15. Thus the potatoes miss the heaviest rainfall and lowest temperatures in the spring, during the time of germination, and are harvested before the heaviest fall rains occur.

SUMMARY

Potato seed treatment experiments for the control of rhizoctonia similar to those conducted in 1924 and in prevoius years were again conducted in

1925 and 1926. Various proprietary compounds were used in comparison with the cold corrosive sublimate, and the cold and hot formalin methods. In 1925 there were 31 different treatments, including the checks, best control being obtained with Semesan Dust when applied at the rate of two ounces per bushel to presprinkled seed. In 1926, there were 55 various treatments including the checks, best control being obtained when presprinkled potatoes were dipped in a 1–120 formalin solution, at 125° F., for four minutes.

Because the results obtained with Dupont Dust No. 15 were so satisfactory in 1924, a series of tests with this compound was conducted in 1925 in addition to the regular tests. The results obtained in 1925 did not compare in any way with the results obtained with the same compound in 1924.

In all of the tests considerable emphasis was placed on sprinkling the potatoes before treatment.

Sclerotia on the tuber surface at harvest time were the basis of disease readings rather than stem lesions during the growing season.

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THE NATURE OF RESISTANCE IN ZEA MAYS L. TO PUCCINIA SORGHI SCHW.

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INTRODUCTION

The study of disease-resistance in plants is one of the most fascinating phytopathological problems, both from a theoretical and from a practical viewpoint. It naturally divides itself into three parts: (1) the mere demonstration of resistance, (2) the genetical nature of resistance, (3) the morphological or physiological nature of resistance.

The literature on the nature of resistance was reviewed by Butler (5) in 1918; by Howitt (9) in 1923–1924, who gives an extensive bibliography; and by Walker (22) in 1924. Walker (22, p. 241) concludes: " . . . the true nature of resistance has been exceedingly difficult to determine and, moreover, it is quite obvious that almost every case of resistance very probably presents a specific problem."

The present paper deals with the nature of corn rust resistance. Several previous workers studied the nature of resistance to rust fungi in other cereals (1, 2, 3, 4, 7, 8, 10, 14, 17, 18, 24, and 25). Their results will be compared with the writer's results later.

MATERIALS AND METHODS

The work was started with two of the physiologic forms of *Puccinia sorghi*,[2] as mentioned by Stakman and Christensen (19). In order to find lines of corn suitable for a study of the nature of resistance, a number of selfed lines were studied with respect to their rust reaction when inoculated artificially in the greenhouse. Two lines were selected for further study. If we call the corn lines A and B, and the rust forms 1 and 2, the rust reaction, expressed in symbols of Stakman and Levine's scale for *P. graminis tritici* (20), was as follows:

	Form 1	Form 2
A	4	1
B	1	4

[1] The work described in this paper was done while the writer was a fellow of the International Education Board, to which he wishes to express his great indebtedness for the opportunities given to him to carry on the present research. Many thanks are due to Dr. E. C. Stakman, head of the Section of Plant Pathology of the University of Minnesota, St. Paul, upon whose suggestion the investigations were started, for hospitality in his laboratory, and for much valuable help.

[2] It has been impossible to compare these two forms of *Puccinia sorghi* with those studied by Mains (13).

Attempts were made to picture the course of infection in both lines of corn. Both forms of rust were originally used, but form 2 proved to be more virulent in susceptible hosts and gave better results. The results described in this paper refer to form 2.

A number of corn plants were inoculated in the usual way (21, p. 432), and daily fixations, during at least 12 successive days, were made of inoculated plants. Controls were made of the type of reaction of the individual plants by fixing only a part of the inoculated leaves or by re-inoculating newly developed leaves. By fixing, cutting, and examining at least four leaves every day, the typical stages of development of the fungus in the leaf were determined.

Most of the material was fixed in chrom-acetic acid (6, p. 25). Gilson's fluid (6, p. 225) was unsuccessful in that it did not fix the host tissue so well as it fixed the fungus. In order to promote penetration of the fixing fluid, the material was placed in vacuum for five minutes. This, however, caused a loss of some of the inoculum in the early stages. Perfect results were obtained by immersing the whole inoculated leaf in the fixing fluid for three or four hours and cutting it into small pieces afterwards.

The sections were cut 8 or 10 μ thick and were stained with saffranin, gentian violet, and organge G, according to the following time schedule:

Saffranin, 1 per cent in 50 per cent alcohol; 5 minutes
Dip in water
Gentian violet, 1 per cent in water; 10 minutes
Dip in water, in alcohol 70 per cent, in alcohol 95 per cent
Few dips in 1 per cent orange G in clove oil
Few dips in clove oil
Xylol, a few minutes
Mount in balsam.

EXPERIMENTAL RESULTS

The Course of Infection in the Susceptible Corn-line

An infected leaf of the susceptible line is shown in figure 1, A. The fungus forms rather large uredo-sori which are not isolated but become confluent. No necrotic or chlorotic areas develop. Microscopically, the infection takes place as follows: The germ tube grows toward a stoma, whereupon it usually forms an appressorium. A very thin infection thread pushes its way through the stomatal slit and becomes a hypha which immediately continues to grow toward some neighboring host cells. The second day after inoculation, the typical stage of development is the one shown in Plate XXX, A. In quite a few cases, however, the mycelium has already penetrated intercellularly in the parenchymatous leaf tissue (Pl. XXX, B). The mycelium

develops further and on the fourth day after inoculation reaches the stage shown in Plate XXX, C. During the following days the whole leaf is invaded by the fungus, which continues its intercellular growth without changing its form. When a certain portion of a leaf has been invaded, the mycelial threads beneath the epidermis thicken considerably. This stage, shown in Plate XXX, D, is usually reached the seventh day after inoculation and is an introduction to spore formation. The next day (Pl. XXX, E) young spores are present, in which the binucleate condition is usually very clear. Plate XXX, F shows all stages of development, *i.e.*, penetration at the right, mycelial development in the parenchyma, and ripe spores at the left. Spores are formed in large quantities, as shown in Plate XXX, G. The newly

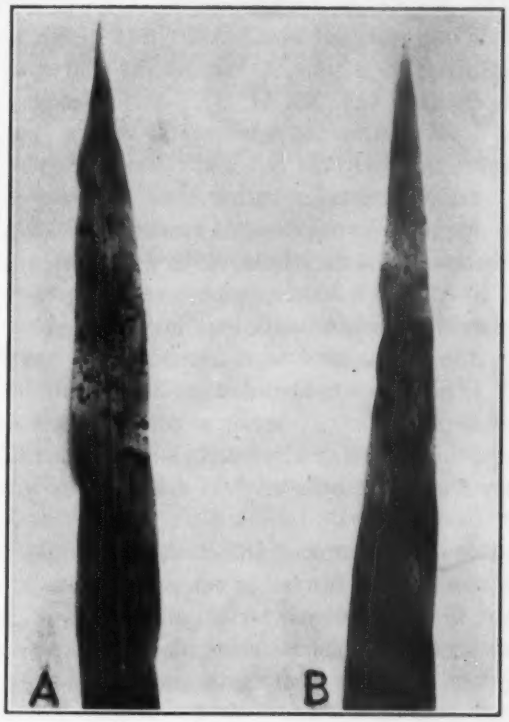

FIG. 1.—Types of infection produced by *Puccinia sorghi* form 2 on seedlings of *Zea mays*: A. On a susceptible line of corn; B. On a resistant line.

formed spores are liberated, and evidently no more than one set of spores is formed in one sorus. Plate XXX, H shows an almost empty sorus on the eleventh day after inoculation; it is remarkable that there is not the least indication of a general necrosis of host tissue at this stage of development and, as a fact, necrosis has not been found at all in the suceptible host.

Two main features in the course of infection of the susceptible host are:

1. There is no evidence of any difficulty which the fungus meets in its development on account of the host plant.

2. The host tissue does not show any sign of suffering from the fungus.

The Course of Infection in the Resistant Corn-line

Figure 1, B shows the disease symptoms as developed in the resistant host: small isolated uredo sori, surrounded by a border of necrotic tissue.

The spore germination, formation of appressoria, and penetration are apparently the same as in the susceptible host. On the second day after inoculation penetration has taken place and an almost spherical substomatal vesicle is formed (Pl. XXXI, A). This substomatal vesicle is very characteristic of the fungus in a resistant host. After this stage has been reached, the fungus stops growing for a time, so that on the fourth day after inoculation it appears unchanged (Pl. XXXI, B). At that stage, however, some hyphal outgrowths develop from the substomatal vesicle, one of which usually reaches a parenchymatous host cell and develops further (Pl. XXXI, C). This development is originally rather slow, so that on the sixth day after inoculation a stage of development is reached (Pl. XXXI, D) which corresponds to the stage on the fourth day after inoculation of a susceptible host (Pl. XXX, C). Although development is relatively slow, a whole portion of a leaf from epidermis to epidermis is invaded and on the ninth day after inoculation young spores have been formed and a few ripe spores are liberated (Pl. XXXI, E). Before abundant spore formation can take place, as occurs in the susceptible host, there is a general necrosis of both host tissue and fungus on the tenth day after inoculation (Pl. XXXI, F and G). This necrosis covers the whole infected leaf area and, of course, stops the development of the fungus.

Two main features in the course of infection of the resistant host are:

1. The development of the fungus is not continuous, as, after penetration has taken place, it stops growing for about two days.

2. After invasion of the leaf has taken place and spore formation has begun, there is a general necrosis of fungous and host tissue.

Comparison Between the Course of Infection in a Susceptible and in a Resistant Host

There are some striking differences between the behavior of the fungus in a susceptible and in a resistant host. The almost spherical shape of the substomatal vesicle is typical of the fungus in a resistant host and is probably a rest form, inasmuch as the parasite remains in this stage for about two days. There may be a distinct substomatal vesicle in a susceptible host;

never, however, is this structure a rest organ. The continuity of infection is typical of the fungus in a susceptible host. The infection thread usually gives rise to a hypha which grows without a rest period and invades the host tissue.

The fungus in a resistant host develops similarly to the fungus in a susceptible one, but later and to a lesser degree. It already has been pointed out that the development on the sixth day in a resistant host corresponds to the stage reached by the parasite in a susceptible host on the fourth day. Furthermore, the ninth day in a resistant host corresponds to the eighth day in a susceptible host. At this stage the mycelium in a susceptible host is considerably thicker than in a resistant host (Plate XXX, E and Pl. XXXI, E).

The most striking difference is the general necrosis which takes place in the resistant host just after the beginning of spore formation, but which is never found in the susceptible host.

THE NATURE OF RESISTANCE

The interpretation of the differences between infection in a susceptible host and in a resistant one is an attempt to indicate the nature of resistance. We might just as well speak of the nature of susceptibility, but, as resistance is usually the more exceptional condition, it draws more attention. Also, it is impossible, of course, to indicate the nature of resistance without, at the same time, indicating the nature of susceptibility.

In view of the fact that the two lines of corn used in the experiments react in an opposite manner to physiologic form 1 as they do to form 2, morphological or anatomical characters cannot be the basis of resistance. We deal, therefore, with a case of true physiological resistance.

It is very clear that there is a quantitative difference between the development of the fungus in a susceptible host and its development in a resistant one, both with respect to time and to fungous material. The development in a resistant host is much slower. In a susceptible host the first stages after penetration has taken place suggest that a certain substance in the host attracts the fungus, so that it grows on immediately. If this substance is not present in sufficient quantity in the resistant host, this would explain why the parasite assumes a rest form after having penetrated the stomatal slit.

The substance in question, if actually present in a larger quantity in the susceptible host than in the resistant one, is very probably a nutritive substance. The difference in quantity explains the quantitative difference between the development of the fungus in a susceptible and in a resistant host.

We have now to account for the necrosis in the resistant host, and this is not easy, for there is no indication at all as to whether the fungus or the

host cells die first. It is possible that, although the fungus in a resistant host finds enough nutritive substance to grow for a time and even to form spores, a condition arises in which all of the available limiting nutritive substance has been used; the fungus dies from starvation, and excretes a certain substance which is harmful to the host cells and causes a necrosis of them. This is a simpler explanation than the hypothesis that toxins and anti-toxins are working, because it is in harmony with the observed quantitative differences in development of the fungus in a susceptible and resistant host. Furthermore, according to the recent research of Sardiña (16), the existence of toxins and anti-toxins in plants has never been proved.

Consequently the differences between the development of the parasite in a susceptible and in a resistant host may be explained by the hypothesis that susceptibility is determined by the presence of a relatively large quantity of a certain nutritive substance which acts chemotropically on the fungus after penetration and makes possible an abundant development of mycelium and spores. This substance is present in very small quantity in the resistant host; therefore there is only a slow and meager development of the parasite. A few spores are formed, but then all the available limiting substance has been used and the fungus dies from starvation, which leads to a necrosis of the host tissue.

There are some more facts which deserve consideration in regard to the above set hypothesis. A great number of types of infection between the extremely susceptible and the extremely resistant ones occur, and there are no sharp distinctions between them. The assumption of quantitative differences among the hosts, controlling the degree of susceptibility, is a plausible explanation. In many of the studies concerning the genetic nature of disease resistance, which several investigators made, the action of multiple factors[3] was found. Although nothing is known about the genetic basis of corn rust resistance, the action of multiple genetic factors would be in perfect harmony with the assumption of a quantitative nature of resistance.

The question arises whether immunity is fundamentally different from resistance. Among the writer's investigated lines of corn, one was perfectly immune from the parasite in question, showing small necrotic flecks without any pustules. Unfortunately, as a very limited quantity of seed of this line was available, only a preliminary investigation could be made. Evidently immunity was nothing but extreme resistance, as the fungus developed in the leaf without any sign of difficulty. However, necrosis started before spore formation had begun, hence at an earlier stage than in the resistant line. This too may be explained on the basis of starvation.

A consideration of the relations between the two lines of corn and the two physiologic forms of the parasite used in the experiments suggests link-

[3] This term refers to the European term "polymeric."

ing up the nature of resistance with the nature of physiologic specialization. The one line of corn was resistant to form 1, and susceptible to form 2 of the rust; while the other line reacted in an opposite way. If physiologic specialization is the requirement of definite food substances and if susceptibility and resistance are determined by the presence or relative absence of those substances, the relations are explained. If this is true, physiologic specialization and resistance are two expressions of one and the same thing, namely, the relation between host and parasite.

The questions discussed may be finally settled by the demonstration of the nature of the substance controlling susceptibility and, by its relative absence, resistance. Mains (12) has shown that the development of *Puccinia sorghi* depends to a great extent on the presence of carbohydrates. It might be that the substance in question is one or another of the carbohydrates, but there is no experimental evidence whatever.

Summarizing, it may be said that there is experimental evidence that the difference between susceptibility and resistance is of a quantitative nature. This suggests that the quantity in which a special nutritive substance is present determines whether the host is susceptible or resistant. It is then plausible to account for the necrosis in resistant hosts by assuming that the fungus dies from starvation and afterwards excretes a substance which kills the host cells. The existence of all possible gradations in the degree of susceptibility between resistance and complete susceptibility is in favor of the idea of a quantitative nature of the differences in question. There is some experimental evidence that immunity is nothing but extreme resistance. Evidently physiologic specialization and resistance are two expressions of the host-parasite relation.

DISCUSSION

Investigations, similar to the one described above, with other rust fungi are reported by several authors. Marshall Ward (24, 25) was the first to study the host-parasite relation in Bromus species with *Puccinia dispersa* and in *Triticum sativum* with *P. glumarum*. He originally was inclined to ascribe the nature of resistance to the action of toxins or anti-toxins. When he failed to isolate or to demonstrate the existence of such bodies, he was in doubt whether resistance was due to the interaction of toxins and anti-toxins or to a starvation process.

Gibson (7), working in Ward's laboratory, studied the infection of several rust fungi, especially of *Uredo chrysanthemi* in a number of different host plants. She rejects the idea of starvation. Dorothea Marryat (14), also working in Ward's laboratory, favors the toxin-anti-toxin idea in the case of *Puccinia glumarum* on wheat. She writes (14, p. 137): "We are therefore forced to fall back upon the theory that immunity to disease is

due in these cases to the production of certain toxins and anti-toxins by host or parasite, or both, which are mutually destructive." It is not evident in Miss Marryat's work which of the two dies first, host or parasite. This is very important, because, when the fungus dies first, starvation may be the cause just as well as a toxic action.

Stakman (18, p. 197), relating to the immunity against *Puccinia graminis*, writes: "Hyphae at the end of five days from the time of inoculation have sometimes killed most of the cells in their immediate vicinity, but still remain alive, although they are usually not vigorous." This would be in favor of a toxic action. In another study, however (17, p. 46), he finds: " . . . they"—the tips of hyphae—"may disintegrate without having first killed host cells." His final conclusion is in favor of the toxin-anti-toxin idea.

Extensive histological studies on the course of infection of *P. graminis* and *P. triticina* were made by Ruth Allen (1, 2, 3, 4). In so far as her work has some bearing on the questions discussed now, she favors the idea that antagonistic reactions between host and parasite form the nature of immunity (1, p. 148). Observations of Helen Hart (8, p. 192) on the infection of *Melampsora lini* in immune flax pointed out that " . . . some of the host cells are killed by the fungus, which is unable to establish itself and finally dies." This would be in favor of an antagonistic action.

The only observations on corn rust reported in the literature are those of Weber (23) and of Mabel Agnes Rice (15, pp. 102–122), who studied especially the development of haustoria. These studies, however, do not give any clue to the nature of resistance.

Considering the different observations reviewed above, there appears to be a general tendency to accept the theory that toxic and anti-toxic reactions determine resistance and immunity, and in several cases there is good evidence. The writer's work, however, gives strong support to the theory that, in corn, resistance to *P. sorghi* is the expression of starvation of the parasite. Many of the results favor the starvation hypothesis of Leach (10, p. 85) on the nature of resistance to *P. graminis*, for which hypothesis there was "very little original experimental evidence" (10, p. 86) when offered. The same author (11) favors the theory of starvation in the case of resistance in beans to *Colletotrichum lindemuthianum*.

It is evident, therefore, that corn rust resistance is of a different nature than resistance to some other rust fungi.

SUMMARY

1. Inoculations with two physiologic forms of *Puccinia sorghi* Schw. on a large number of selfed lines of corn showed that a certain line was sus-

ceptible to one rust form and resistant to the other, while another line reacted in an opposite way.

2. A histological study was made of the course of infection of one of the forms of the parasite on the two corn lines mentioned above.
3. The following differences between the infection of the susceptible and of the resistant host were detected:
   a. After penetration, the parasite in the resistant host forms an almost spherical substomatal vesicle and stops growing for about two days; in the susceptible host the fungus grows on immediately after penetration.
   b. The development of the fungus in the resistant host is much slower and does not progress so far as in the susceptible host.
   c. In the susceptible host there is abundant spore-formation and no necrosis; whereas in the resistant host only a few spores are formed, and a general necrosis of both host cells and fungus follows immediately.
4. The differences are quantitative and may be explained by the assumption that the amount in which a special nutritive substance is present determines the degree of susceptibility.
5. The necrosis in the resistant host may be accounted for by the assumption that, after a few spores have been formed, the fungus dies from starvation and then excretes a substance which kills the host cells.
6. There is some experimental evidence that immunity is nothing but extreme resistance.
7. Physiologic specialization and resistance can be considered as the two expressions of the host-parasite relation.
8. Most of the investigators who studied the nature of resistance to several rust fungi other than *P. sorghi* are inclined to assume the action of toxins and anti-toxins. Since there is no such indication in the writer's work, the nature of corn rust resistance seems to be different from that in other rust fungi so far studied.

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EXPLANATION OF PLATES

PLATE XXX

Sections of a susceptible line of corn after inoculation with physiologic form 2 of *Puccinia sorghi*, illustrating the course of infection. (Drawings made with the aid of a Leitz drawing ocular at a magnitude of about 450 and presented here at a magnitude of about 270.)

A. Two days after inoculation, showing urediniospore, appressorium, infection thread, and hypha. B. Two days—showing appressorium and hypha. C. Four days after inoculation—spores, substomatal vesicle, hypha; immediately ahead of the substomatal vesicle are two hyphal nuclei. D. Seven days—thick mycelium beneath epidermis, a preliminary to urediniospore formation. E. Eight days—young spores, many binucleate. F. Nine days—appressorium and empty substomatal vesicle (at the right); mycelium inside the leaf and a group of mature urediniospores (at the left). G. Nine days—ripe urediniospores in abundance. H. Almost empty uredo-sorus; no general necrosis of host tissues.

PLATE XXXI

Sections of a resistant line of corn after inoculation with physiologic form 2 of *Puccinia sorghi*, illustrating the course of infection. (Drawings made the same way as in Plate XXX, presented here at a magnitude of about 340.)

A. Two days after inoculation—urediniospore, appressorium, enlarged spherical substomatal vesicle. B. Four days after inoculation—same as A. C. Four days—appearance of hyphal outgrowths from enlarged substomatal vesicle. D. Six days—appressorium, substomatal vesicle, hypha. E. Nine days—mycelium inside the leaf; young, binucleate, urediniospores at the left. F. Ten days—general necrosis of host tissue and of rust fungus. G. Same as F.

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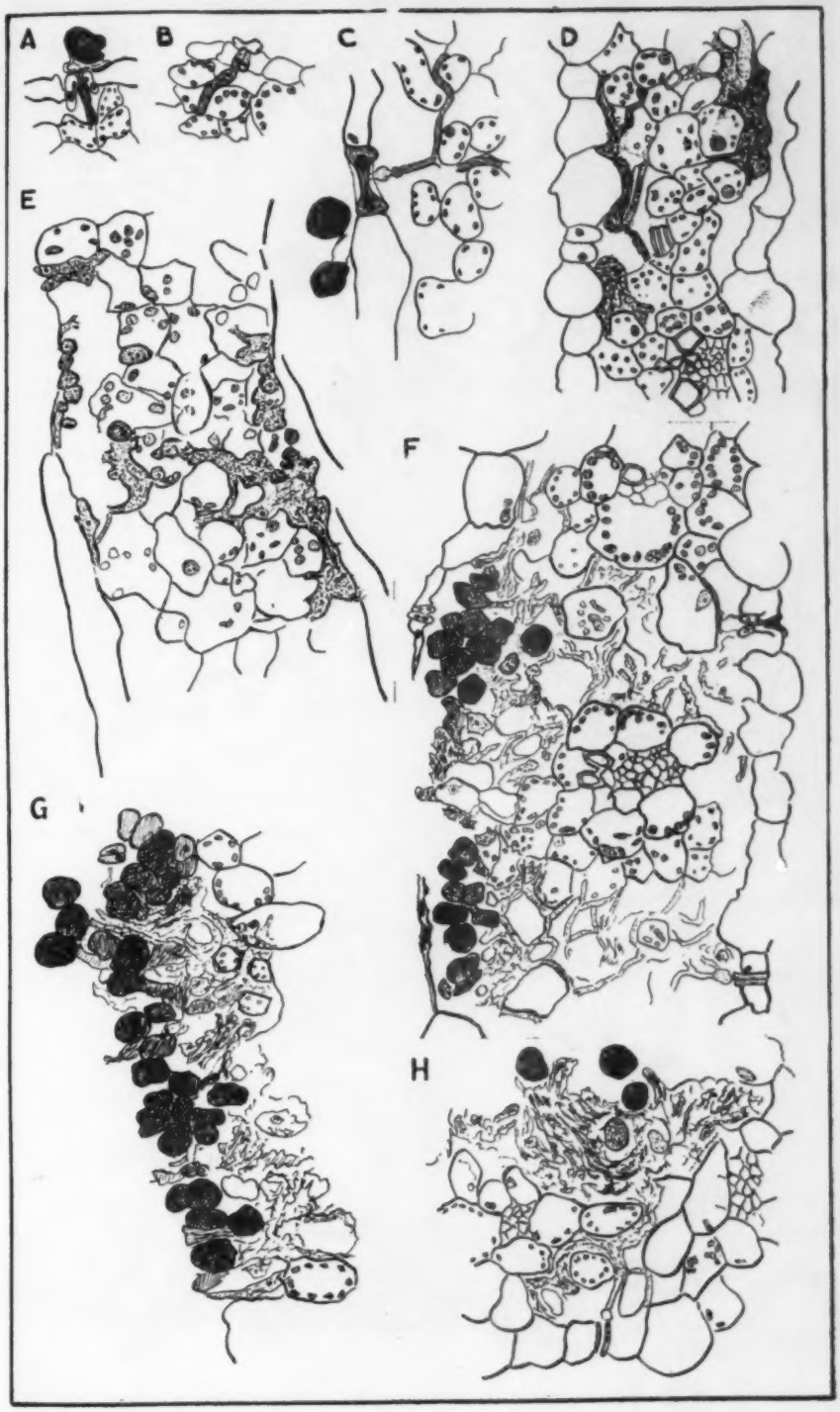
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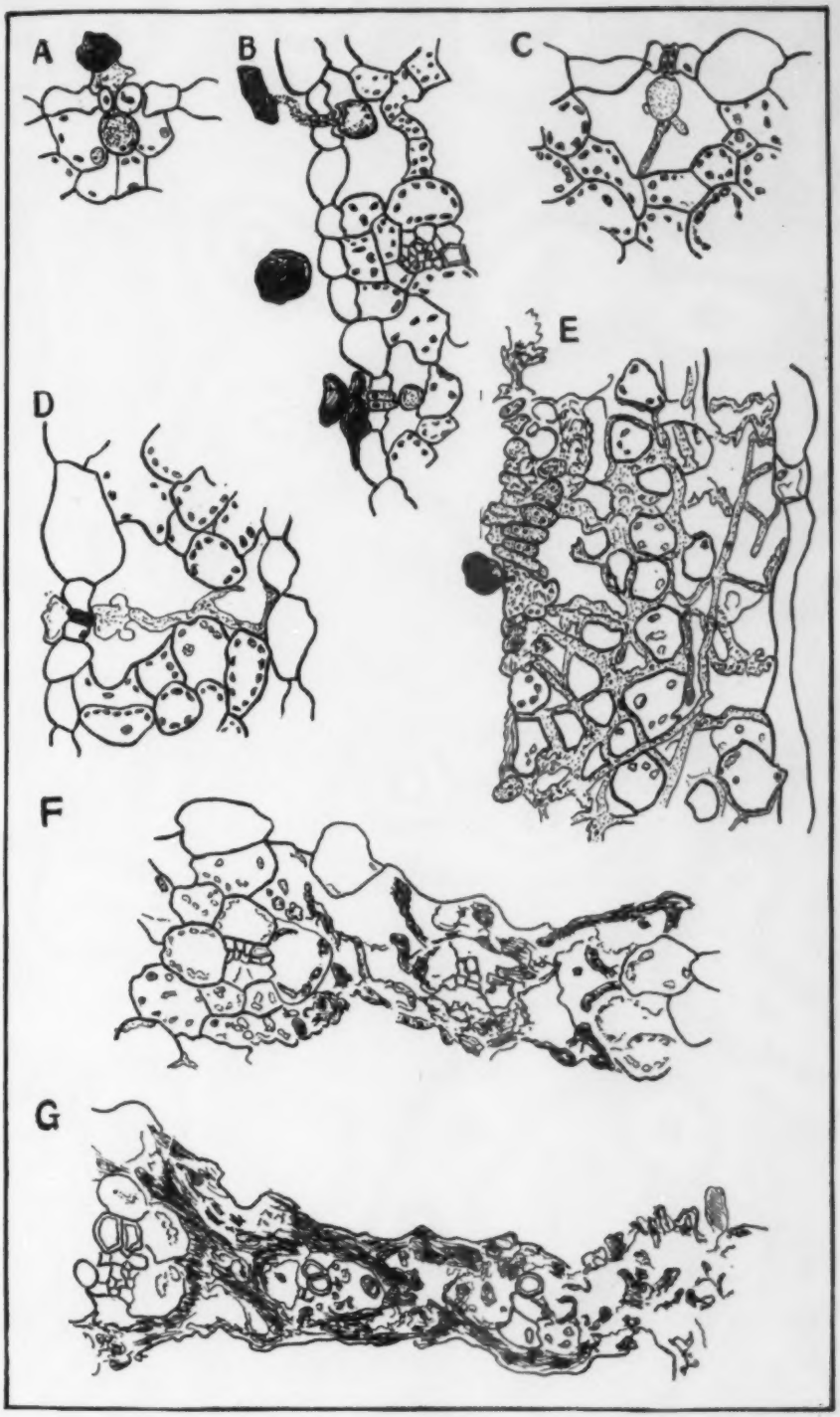
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HETEROTHALLISM IN USTILAGO ZEAE[1]

E. C. Stakman and J. J. Christensen

INTRODUCTION

It has been shown by Kniep (5 and 6), Zillig (13), Bauch (2 and 3) and others that there are sexual strains in many species of smut fungi. These strains may be morphologically isogamous but functionally heterogamous. Kneip (6) has shown that fusions also may occur between different species, and he describes cases in which sporidia or germ tubes of several different species all fuse together. This is very suggestive of the origin and stability of physiologic forms in smut fungi.

Kniep (5) in 1919 showed that sporidial cultures of *Ustilago violacea* (Pers.) Fuckel. from different host plants differed in appearance. Zillig (13) in 1921 demonstrated clearly that there are distinct physiologic forms of this fungus which can be distinguished from each other by their pathogenicity for certain members of the Caryophyllaceae. Liro (7) and Bauch (4) confirmed Zillig's observations and extended them somewhat. Zillig also showed that there are sexual strains within individual physiologic forms and further that fusions may occur between sexual strains of different physiologic forms. When plants were inoculated with the sporidia of one sex only, that is, haploid sporidia, no infection resulted, indicating that the diploid condition is necessary for infection.

Stakman and Christensen (12) and Christensen and Stakman (1) demonstrated that there are many physiologic forms of *Ustilago zeae* (Beckm.) Ung., and evidence was presented that new forms might arise through mutation. It seemed quite likely that they might arise also as a result of hybridization, because of the fact that many physiologic forms or cultural types often were isolated from single collections or even from single smut galls. The large number of types thus obtained suggested very strongly that the material was heterozygous. For this reason it was decided to make a study of the possible rôle of hybridization and subsequent segregation in the origin of physiologic forms. In the meantime, however, evidence of the existence of sexual strains was obtained as a result of field experiments.

FIELD EXPERIMENTS

During the summer of 1927, an attempt was made to determine the effect of inoculating certain varieties of corn with single physiologic forms of

[1] Published with the approval of the Director as paper No. 741 of the Journal series of the Minnesota Agricultural Experiment Station.

Ustilago zeae and with combinations of two, four and eight forms. It was observed that more smut galls always developed on plants inoculated with mixed cultures than on those inoculated with a single form. However, the results of inoculating with two forms sometimes were almost as good as those obtained by inoculating with four or with eight forms. It was quite evident that the virulence of mixtures of several forms was not due simply to the additive effect of the component forms. Apparently something strikingly new had happened. For this reason a field experiment was made in order to determine more accurately the results of inoculating corn with single forms and with various combinations of forms.

All of the physiologic forms used in the field experiment had been isolated from material collected in Minnesota. While they were not monosporous cultures, they had been grown from one to three years on many different media and appeared to be pure types, although sectors appeared in some of them. The forms differed from each other consistently in appearance when grown on artificial media. Because of the distinct and consistent differences in appearance and in certain physiological characters, they naturally were considered as different physiologic forms. These particular forms, designated as M2, M3, M4, and M7, were selected because they failed to cause infection when used in previous field experiments in which many other forms alone caused various degrees of infection on at least some pure lines of corn.

Inoculum for the experiments was prepared by growing each form separately in a solution of 2 per cent dextrose and 1 per cent malt-syrup. The cultures were allowed to develop for from 2 to 3 weeks before inoculations were made. They were then strained through cheese-cloth in order to remove the largest clumps of solid material. When inoculations were made with 2 forms together, the cultures were mixed just before inoculation. The inoculum was injected into the plants by means of a hypodermic syringe, as near the growing point as possible. The controls were inoculated in the same manner with sterile nutrient solution.

Between 50 and 65 plants of Golden Bantam corn were inoculated with forms M2, M3, M4, and M7 separately, and about the same number with each of the following combinations: M2 and M3, M2 and M7, M3 and M4, and M3 and M7. Golden Bantam was selected instead of a selfed line because it was known to be susceptible to a large number of physiologic forms. The results are given in table 1. Apparently no one of the forms alone caused the formation of smut galls, although it appeared as though the plants became infected, because the tissues, sometimes extending several inches from the point of inoculation, were more or less translucent, and because the plants inoculated with some forms were decidedly stunted. While galls appeared on some of the plants, they evidently resulted from

TABLE 1.—*Results of inoculating Golden Bantam corn in the field with individual physiologic forms of Ustilago zeae and with various combinations of forms*

Forms of *Ustilago zeae*	No. plants inoculated[a]	No. plants free from infection[b]	No. plants infected	
			Incipient	With galls
M2	61	61	0	0
M3	65	63	0	2
M4	59	51	0	8
M7	60	53	1	6
M2 and M3	62	2	9	51
M2 and M7	60	9	4	47
M3 and M4	62	59	1	2
M3 and M7	51	50	1	0
Control	61	53	3	5

[a] Plants from 6 to 10 inches tall when inoculated.

[b] When final notes were taken.

natural inoculation and, except in one case, no more galls developed on those plants inoculated with single forms than on the controls. The experiment was made rather late in the season when smut was prevalent in the field, and a certain amount of natural inoculation was to be expected. Smut galls developed on a large percentage of plants inoculated with forms M2 and M3 and with forms M2 and M7, but not on those inoculated with forms M3 and M4 and forms M3 and M7. This indicates, therefore, that there prob-

TABLE 2.—*Results of inoculating Golden Bantam corn in the greenhouse with individual physiologic forms of Ustilago zeae and with various combinations of forms*

Forms of *Ustilago zeae*	No. plants inoculated[a]	No. plants free from infection[b]	No. plants killed[c]	No. plants with galls
M2	44	44	0	0
M3	36	36	0	0
M4	40	40	0	0
M7	43	42	0	1
M2 and M3	37	12	1	24
M2 and M4	39	17	1	22
M2 and M7	43	8	19	15
M3 and M4	42	42	0	0
M3 and M7	38	38	0	0
M2, M3, M4, and M7	35	15	6	17
Control	44	44	0	0

[a] Plants from 3 to 5 inches tall when inoculated.

[b] No visible evidence of infection when final notes were taken.

[c] Some plants were killed before galls were completely formed.

ably are at least two sexes, form M2 being of one sex, and forms M3, M4, and M7 of another.

GREENHOUSE EXPERIMENTS

Although the results of this field experiment seemed quite conclusive, the experiment was repeated in the greenhouse. The methods were essentially the same as those used in the field. The results are given in table 2.

It will be seen from table 2 that the results of the experiments in the greenhouse confirmed those obtained in the field. Smut galls were produced on a large percentage of plants inoculated with the following combinations of forms: M2 and M3; M2 and M4; M2 and M7; and M2, M3, M4, and M7, but only one was produced on any of the plants inoculated with

TABLE 3.—*Results of inoculating Golden Bantam corn in the greenhouse with individual physiologic forms of Ustilago zeae and with various combinations of forms*

Forms of *Ustilago zeae*	No. plants inoculated[b]	No. plants free from infection[c]	No. plants killed[d]	No. plants with galls
N. H.[a]	21	21	0	0
Miss.	17	17	0	0
Can.	28	28	0	0
M2	19	19	0	0
M3	16	16	0	0
M9	17	17	0	0
M2 and M3	24	2	11	14
M2 and M4	18	1	8	14
M2 and Miss.	23	1	12	16
M3 and Miss.	25	25	0	0
M2 and Can.	21	3	12	10
M3 and Can.	20	20	0	0
M2 and N. H.	21	1	1	19
M3 and N. H.	24	24	0	0
M2 and M9	22	1	1	20
M3 and M9	24	24	0	0
Miss. and Can.	23	23	0	0
N. H. and Miss.	24	24	0	0
Can. and N. H.	22	22	0	0
M9 and Miss.	29	29	0	0
Control	23	23	0	0

[a] N. H. refers to the form from New Hampshire; Miss. the form from Mississippi; and Can. the form from Canada.

[b] The plants were from 6 to 10 inches tall when inoculated.

[c] No visible evidence of infection when final notes were taken.

[d] Some plants were killed before galls were completely formed.

single forms. It is evident from these experiments that form M2 is of one sex and M3, M4, and M7 are of opposite sex.

Still another experiment was made in the greenhouse. Plants were inoculated with various combinations of forms, as indicated in table 3. In table 4 are summarized all the pairings which were made. Apparently M2 is of one sex while all the other forms used are of the opposite sex.

TABLE 4.—*Summary of results of inoculating Golden Bantam corn with various physiologic forms of Ustilago zeae*

Form	N. H.	Miss.	Can.	M2	M3	M4	M7	M9
N. H.	–[a]	–	–	+	–			
Miss.	–	–	–	+	–			–
Can.	–	–	–	+	–			
M2	+	+	+	–	+	+	+	+
M3	–	–	–	+	–	–	–	–
M4				+	–	–		
M7				+	–		–	
M9		–		+	–			–

[a] –, no galls formed; +, galls formed.

OBSERVATIONS ON SEXUAL FUSIONS

The question naturally arises as to where the sexual fusions occur. It is well known that the sporidia of some of the smut fungi copulate, but there is conflicting evidence on this point regarding the behavior of *Ustilago zeae*. Maire (8) and Sartoris (10) both state that the sporidia fuse, and the former shows a figure of fused sporidia. However, Seyfert (11) questions whether the sporidia actually do fuse and states that the methods used so successfully to demonstrate the fusion of sporidia in many other smut fungi have not been successful in the case of *U. zeae*. According to Rawitscher (9) and Seyfert (11) the sexual fusions of *U. zeae* occur in the corn plant before the formation of chlamydospores. According to Rawitscher the process is as follows. The sporidia are uninucleate. They may cause infection of the corn plant, in which they produce an intercellular uninucleate mycelium. The mycelium breaks up into short hyphae which are still uninucleate. Neighboring cells may fuse, thus giving rise to binucleate cells which eventually become chlamydospores. Rawitscher

was not able to observe the actual process of nuclear fusion because of the small size of the nuclei. However, he states that it must occur in the rather young spore cells, as the older ones and the mature chlamydospores are uninucleate. He does not mention clamp connections, although his figures suggest strongly that they were present in his material. Hyphae which do not fuse, and therefore remain uninucleate, do not form spores. Seyfert (11) also made some cytological studies and concluded that clamp connections were very abundant on the hyphae inside of the corn plant a considerable time before the formation of chlamydospores.

The writers made numerous observations to ascertain whether the sporidia of M2 would fuse with those of opposite sex. Forms M2 and M3, M2 and M7, and M2 and M4 were grown side by side on potato dextrose agar in petri dishes. In all cases the colonies grew together but no fused sporidia could be found. These forms also were grown together in flasks of dextrose and malt solution. There usually was rather abundant surface growth, but on microscopic examination of this material no evidence of sporidial fusions could be detected. Hanging drops in van Tieghem cells also were inoculated with single forms and with the proper combinations, but no fusions could be observed. Finally the method described by Bauch (2) was used. Sporidia of the individual forms were first transferred separately into test tubes containing a 0.01 per cent malt solution. The tubes were then shaken and approximately 2 cc. of each poured into a petri dish. Bauch found that the sporidia of different sexual strains of *Ustilago violacea* copulated abundantly within two days under these conditions. The writers could find no evidence that the sporidia of *U. zeae* copulated, although more observations will be made.

A histological study was made to ascertain whether clamp connections were formed in corn plants inoculated with single physiologic forms and in those inoculated with two. It was impossible to find any evidence of clamp connections in the tissues of corn plants inoculated with single forms or with combinations of forms which failed to cause the formation of galls. However, hyphal fusions and numerous clamps were observed in the tissues inoculated with forms M2 and M3, M2 and M4, and M2 and M7.

CONCLUSIONS

Ustilago zeae evidently is heterothallic. In the present investigations it was shown that certain physiologic forms alone would not cause infection, but when used in combination with M2 they caused infection readily. The question naturally arises as to whether these so-called physiologic forms therefore actually are physiologic forms or merely different sexual strains. The writers are of the opinion that it is justifiable to consider them as physiologic forms because they differ from one another in appearance and also in

their biochemical reactions, as is indicated by their behavior when grown on standard bacteriological media. As they differ from one another in many characters other than sex, it seems reasonable to consider them as physiologic forms in which the sporidia are all of one sex.

Many physiologic forms with which the writers made inoculations caused infection alone. Hence it seems likely that they comprise two morphologically similar sexual strains. Experiments are now under way to ascertain whether this is true.

The results suggest that many of the physiologic forms of *U. zeae* have arisen by hybridization, and it seems probable also that new forms are continually arising by the same process. Whether the mutations previously described by the writers can be explained on the basis of segregation remains to be seen. Some of the apparently unisexual strains used in these experiments produce sectors under various conditions. Of course these strains may comprise several physiologic forms, all of the same sex. However, there is good evidence that true mutants appear. This phase of the problem is being investigated in detail and the results will be published later.

SUMMARY

1. *Ustilago zeae* apparently is heterothallic. The fusion of two strains of opposite sex seems to be prerequisite to the formation of chlamydospores in the host plant.

2. When corn is inoculated with certain physiologic forms of *Ustilago zeae* alone, no smut galls are formed, but when inoculated with these same forms in combination with another form, presumably of opposite sex, smut galls are formed on a large percentage of plants.

3. So far, evidence has been obtained for the existence of only two sexes.

4. Some physiologic forms alone cause gall formation, suggesting that these forms comprise morphologically isogamous but functionally heterogamous strains.

5. No evidence was obtained that the sporidia of strains of opposite sex fused in artificial culture. However, hyphal fusions and numerous clamp connections were observed in plants which had been inoculated with two strains of opposite sex but not in those which were inoculated with unisexual strains alone, nor in those inoculated with combinations of strains of the same sex.

6. It is suggested that new physiologic forms are being produced by hybridization and consequent segregation.

7. The production of sectors by certain unisexual strains suggests that new forms are arising by mutation also.

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PHYTOPATHOLOGICAL NOTES

Effects of fungous extracts upon the initiation and growth of the perithecia of Venturia inaequalis (Cke.) Wint. in pure culture.—The stimulatory effect of fungous extract upon the production of perithecia by *Thielavia basicola* Zopf has been reported by Miss McCormick.[1] In some recent work the present writer observed a similar stimulatory effect when certain fungi occurred as contaminants in petri-dish cultures of *Venturia inaequalis*. The perithecia of *V. inaequalis* were more abundant and of greater size in a zone near the periphery of the colony of the contaminant. A *Penicillium* was grown in pure culture on oatmeal agar. After two weeks the agar containing this fungus was macerated in clean white sand and a water extract made. This extract was forced through a Berkefeld filter, and the filtrate was found to be sterile when small amounts of it were plated out. Five petri-dish cultures of *V. inaequalis* on oatmeal agar, in which no perithecia had appeared, were treated with 1 cc. each of this extract; five cultures were treated with 1 cc. each of the same extract after it had been autoclaved at 12 pounds pressure for 20 minutes; and five cultures were treated with 1 cc. each of sterile distilled water. The liquid was spread over the agar by tipping the petri dishes from side to side. After keeping these cultures at 16° C. for one week, data were taken on the abundance of the perithecia and on their diameters. Perithecia were counted in 40 microscopic fields selected from each plate in areas where the fungus occurred in abundance (one microscopic field was 2.5 sq. mm. in area). Measurements were made of the diameters of 50 perithecia in each plate, when that number could be found. The results appear in table 1.

TABLE 1.—*The effect on number and size of perithecia when Penicillium extracts are added to cultures of Venturia inaequalis*

Liquid added to cultures	Perithecia	
	Av. no. per 100 sq. mm.	Av. diam.
Check, 1 cc. sterile water	2	37 μ
1 cc. Penicillium extract, autoclaved	6	49 μ
1 cc. Penicillium extract, not autoclaved	25	67 μ

Furthermore, there had been a greater vegetative development of the fungus in the cultures treated with the unautoclaved extract. It is noteworthy that there appeared to be a slight stimulation both of perithecial and

[1] McCormick, Florence A. Perithecia of *Thielavia basicola* Zopf in culture and the stimulation of their production by extracts from other fungi. Conn. Agr. Exp. Sta. Bul. 269: 539–554. 1925.

mycelial development in the plates treated with the autoclaved extract.—E. E. WILSON, *College of Agriculture, Madison, Wisconsin.*

Summer meeting.—The summer meeting of the American Phytopathological Society, under the auspices of the Advisory Board, was held in 1927 in Ohio, August 16–19. Local arrangements were in the hands of a committee composed of H. C. Young, W. G. Stover, Curtis May, Paul E. Tilford, and R. C. Thomas. The meeting took the form of a tour of northern portions of the state for the purpose of studying, primarily, diseases of fruits and vegetables. Preceding the tour, an inspection of the laboratories, greenhouses, and Experiment Station farm was made. Registration of 70 in attendance showed good representation from all sections east of the Mississippi River and from Canada. Variety marked the meeting: a large number of crops and diseases was observed; types of commercial field production were visited; and any possible monotony which might have arisen from an extended auto tour was broken by a boat trip to Kelley's Island and Put-in-Bay.

One of the striking features of the meeting was the results noted in plots of oats which had been treated in various ways for smut. Two new dusts, with formaldehyde and iodine respectively as the base, gave remarkably complete control over heavily smutted checks. Further announcement of this work is to be made in *Science* at an early date.

Potato spraying and dusting experiments were inspected both in plots at Wooster and on a large farm near Smithville where there were 250 acres of potatoes. Visitors availed themselves of the ample opportunity afforded in the field for full discussion of the several aspects of potato disease control.

Other striking and interesting studies included plots of Michigan resistant celery, onion pink root, raspberry virus troubles, winter injury on peaches, *Bacterium pruni* in relation to fertilizers, and grape spraying.

The many pleasant features of the meeting can not be enumerated. Breakfast, served in the laboratories at the Experiment Station, made possible the beginning of good fellowship which prevailed throughout the tour. The Celery Growers' Association at Celeryville gave a supper which promoted mutual acquaintanceship between the growers and pathologists. Impromptu talks, by Mr. Nelson on celery root rot and Michigan resistant celery, by Dr. Newhall on "seeders," and by Dr. Chupp on celery leaf diseases, were plainly impressive. The growers displayed keen interest in the questions raised by the speakers, while the younger pathologists in attendance were given a demonstration of good methods of extension presentation.

According to the visitors, credit for the success of the excellent program, both of fun and business, is due the Ohio pathologists.

PHYTOPATHOLOGY

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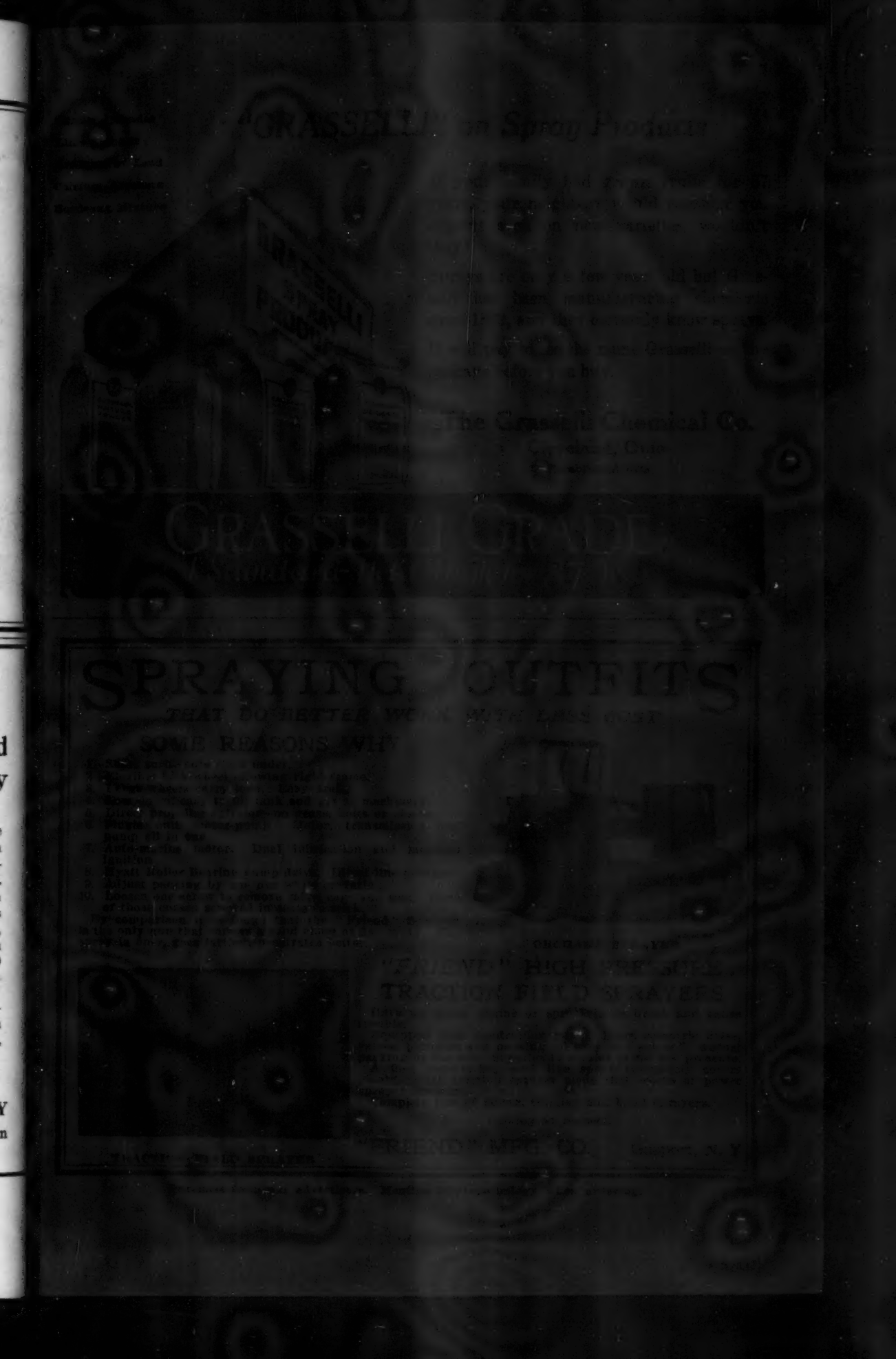
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